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The Aurora

By K. K. Darrow

DOMESTICATED electricity, the electricity of audions, of lamps and broadcasting, is so familiar as almost to have entered into Keats' "dull catalogue of common things"; but wild electricity, when it discloses itself in the ordinary course of nature in ways not arranged by human intervention, is still something rare and majestic. It is a rather strange fact that electrical outbursts in nature are unusual—a fact which of course must never be taken to mean that electricity itself is rare, than which nothing is farther from the truth. Electricity pervades all matter; but it manifests itself only when the two kinds of it, negative and positive, have been torn apart, and are engaged in re-uniting themselves. An electrical effect is the sign of a violent reunion; but the reunion has to be preceded by a separation, and separations of this violence rarely occur by natural processes, at least not upon this tranquil earth. One can rapidly count over the instances in which these separations and reunions naturally happen. There is the thunderbolt, for which familiarity does not breed contempt; there is the torpedo, not the instrument of warfare, but the fish who originally enjoyed the monopoly of the name, and whose shocks are credibly reported to be quite an event to the person who experiences them; there are the luminous balls which occasionally appear on the mastheads and cross-arms of ships (one can sympathize with the mediaeval sailors for regarding them with a superstitious dread!); and there is the Aurora of the north.

The Aurora must be a very splendid sight; the words which its witnesses use to describe it are evidence enough for that. Unfortunately I cannot speak of it with the vividness of reminiscence, having seen it but once, and then under the low latitude of 42°, on an evening when it appeared as a fluctuating pale green glow spread over the northern sky. American latitudes and metropolitan lights are not favorable to this spectacle. The Aurora has several of the qualities necessary for romance, and one of them is that it reserves its full

grandeur for those willing to expend effort and bear with inconvenience; Arctic explorers, for instance, and men of science who have established themselves in regions like Spitzbergen and Finmark, that desolate northern end of Norway known to the readers of *Growth of the Soil*. These speak of bands, and arcs, and arches, curtains of light, draperies, and crowns; and of gorgeous colors; and of a perpetual pulsation and a shimmering, responsible for the delightful English-dialect name of "merry dancers." Evidently this celestial theatre is something worthy of a long journey; if it should ever be announced for New York, a lightless night should be decreed in its honor.

The Aurora confines itself to great heights; it rarely descends to as low an altitude as fifty miles, and from the lower boundary which it fixes for itself it extends upward for hundreds of miles. No aviator has soared into the domain of this exalted glow; it is safer than any mountain-top from being contaminated by the physical presence of men; not merely difficult to see, but impossible to attain.

On analyzing the total light of the Aurora into the several kinds of light which are combined in it, one finds that some of them are otherwise unknown. This may not seem surprising; why should one expect merely to rediscover, in the rays proceeding from this inaccessible region of the high arctic air, only the sorts of light which arise in the familiar conditions of the laboratory? Yet, among the radiations of the immensely distant stars, one finds chiefly such light as can be reproduced with electric arcs and sparks; and it is tantalizing that new and unfamiliar rays should be produced in such profusion so near home. Sixty years ago rays otherwise unknown were discovered coming from the corona of the sun, but subsequently new elements were discovered on the earth to which they were found to belong. At present there is confidence (possibly delusive) that the system of the elements is almost completely known; it is not likely that the upper air contains an element never detected in the lower.

The most famous of these auroral rays is a green light, which often imposes its own color upon the auroral display, and is never altogether absent from the night sky, for a sensitive photographic plate turned upward and left uncovered for a few hours of the night will always record it. There are two eminent scientists, each of whom thinks he has lately reproduced it, each in a different way. This is no place to attempt to judge which, if either, is right; each has learned to produce a new sort of light, whether or not it is precisely the green light of the Aurora. One drives streams of electrons against crystals of frozen nitrogen, and they shine with a green light persisting even after the bombardment with electrons is discontinued; if this is truly the light of the Aurora, then the region in which it shines must contain myriads of these crystals, and they must be colder than thirty-five degrees above the absolute zero, for nitrogen crystals warmer than this remain solid indeed, but pass through some mysterious change into a state in which they do not shine. The other scientist drives streams of electrons into a mixture of helium with a little oxygen, and a green light appears which is never emitted by pure oxygen nor by pure helium; some-

thing which recalls many phosphorescing substances, which are mixtures of two chemicals, neither of which when free of the other possesses any power of phosphorescence whatever. If this is the green light of the Aurora then the upper air of the polar regions must be a delicately-proportioned mixture of oxygen and helium. But there must be nitrogen there also, for some of the other components of the light of the aurora are those of luminous nitrogen.

The crystals of nitrogen, or the molecules of oxygen, or whatever it is that emits the auroral light, must be stimulated into emission by something which comes from above, and which is influenced by the magnetism of the earth; for the auroral streamers often follow the directions of the magnetic force proceeding from the earth, and diverge from that point of the sky which would be the zenith if one were at the earth's magnetic pole, far up in the arctic regions of Canada. A Norwegian scientist covered an iron sphere with a coating of phosphorescent matter, magnetized it, enclosed it in an evacuated vessel and directed a stream of electrons against it; and this "terrella" or "little earth" glowed where the electrons struck it, over regions which formed patterns around its magnetic pole somewhat like the regions on the earth's surface where the aurora is most plentiful. Apparently the Aurora is itself stimulated by a rain of electrified particles pouring from the outer space against the earth; probably they come from the sun, for great auroral spectacles accompany sunspots and other occasional solar phenomena. Thus the sun not only lavishes light upon the earth, but sends some of its own substance across the intervening space.

Saving The Radio Market

"It has had its summer slumps, and it still is suffering from overproduction and the dumping of obsolete models upon the market. A further hindrance has been unfulfilled promises of results that could be accomplished. Probably the greatest saving factors have been the improvement of programs presented by the broadcasting stations and the linking up of broadcasting stations through the American Telephone and Telegraph Company's long-distance lines for the broadcasting of good music and events of national importance."—Extract from Radio Development and Consumer Buying Motives, Harvard Business Review, January, 1926.

Two-Way Transatlantic Radio Telephony

By John Mills

TWO-WAY transatlantic radio telephony became on Sunday, March 7, a recognized accomplishment. Representatives of the press in Europe and in the United States gathered at the respective terminals of the circuit and for almost four continuous hours took part in radio conversation with each other. Their reports of this achievement were widely published on the following morning and formed the first formal announcement to the public of the progress in this field of radio which has been accomplished under the coordinating guidance of the American Telephone and Telegraph Company.

Some intimations had already been obtained by the closer students of radio. Basic studies of the transmission efficiency of ether paths from Europe to the United States, reported by Messrs. Espenschied, Anderson, and Bailey, had foreshadowed to some the approaching successful experiment. Others had noted other activities, and particularly the association of Bell System engineers with those of the Radio Corporation of America at the Rocky Point transmitting station of the latter company. A few may have listened to some of the tests which have been going on for some time. For many, however, the most authori-

Harold W. Nichols and John C. Schelleng

Harold T. Friis

tative intimation had preceded by almost three years. They remembered the earlier experiments of 1923 when transmission had been attempted only in one direction, that toward England, but had been remarkably successful.

The 1923 experiments, which were in the nature of a demonstration of possibilities, followed plans of the American Telephone and Telegraph Company and, as in the present case of two-way transmission, were carried out in the United States through the cooperation of the Radio Corporation of America which furnished the station and use of antenna equipment. The methods employed were at that time summarized in a paper before the Institution of Electrical Engineers in London by H. W. Nichols.

To Dr. Nichols had been given immediate charge of the radio-circuit development work which was one of the contributions of our Bell Laboratories to the 1926, as well as to the 1923, accomplishments. In his organization of that job he had assigned to R. A. Heising the development of the side-band generator and low-power amplification. Assisting Mr. Heising were J. C. Gabriel, H. R. Schmidt and G. Thurston. The development of the high-power equipment, the radio circuits, and the radio-transmitter operation Mr. Nichols assigned to A. A. Oswald and J. C. Schelleng; and they were assisted by H. R. Knettles, J. P. Schafer, M. E. Fultz and E. J. Sterba. The production of field measuring sets became the problem of C. R. Englund.

Further developments in high-power vacuum-tubes were undertaken by W. Wilson and in more detail by M. J. Kelly. The copper-glass seal had already been contributed by W. G. Houskeeper and other assistance was given by Messrs. Banta, Ronci and Griffith.

This was the personnel of the Laboratories which was specifically concerned with transatlantic radio during 1922. In December of that year Dr.

Raymond A. Heising

Nichols and Mr. Friis went to England to locate the receiver. Reception was carried out by Mr. Friis with the assistance of members of the Western Electric Company, Limited. In the following January, 1923, the demonstration occurred and H. B. Thayer, then president of the American Telephone and Telegraph Company, talked to England. It was the success of this work and his lucid exposition of it which won for Dr. Nichols the Fahie award to which E. H. Colpitts referred in his appreciative note printed in the RECORD for January, 1926.

In the long series of transmission tests, which then followed, use was made of field measuring sets designed by Mr. Friis. On the part of the Laboratories these tests on the American side of the water were participated in by Messrs. Knettles, Schafer, Fultz, Burrows, Toth, Gabriel, Llewellyn, Thurston and McTernan.

Carl R. Englund

Arthur A. Oswald

Some months after the 1923 demonstration Mr. Schelleng went to England to demonstrate our power tubes to the British Post Office. Later A. A. Oswald went across to act as consultant on matters of circuits and operation. Except for a few months' return to the United States he has been continuously concerned with the developments at the English terminal and was operating the station at the time of the 1926 experiments, which the newspapers recorded. Mr. Knettles, who followed him some time later has also been there continuously, engaged in engineering and manufacturing phases of the work.

In the meantime at West Street the necessary radio-telephone equipment was rapidly passing from its research form into commercial form with corresponding problems of apparatus and systems development. The radio equipment originally used at Rocky Point had been a research product, but the proposed equipment, both for receiving and for all low-power radio operation, including modulation, was

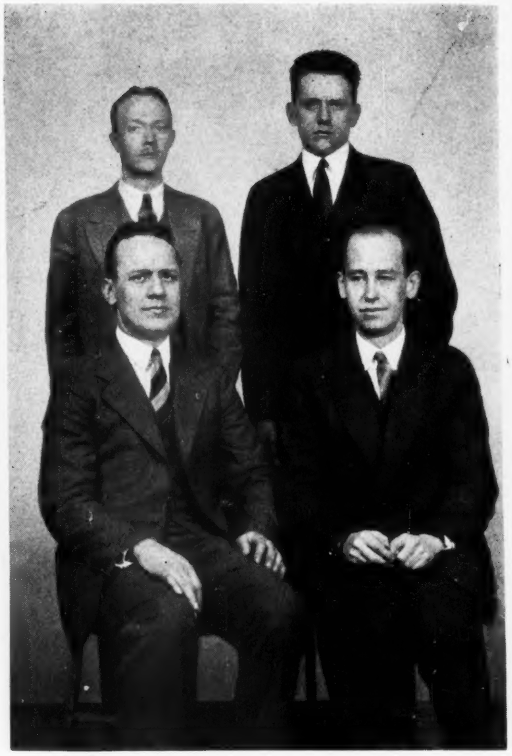
William G. Houskeeper and William Wilson

made the responsibility of the carrier-current group of the Systems Development Department under B. W. Kendall. In clarifying the radio requirements the Research Department cooperated through Mr. Heising, and the Systems Department attacked the problem through R. E. Coram of C. W. Green's group, who was assisted by Messrs. Engstrom, Weis, Wennemer, and Lorance. Some problems of mechanical design were coordinated by J. J. Kuhn and B. O. Templeton, and in this work L. G. Hoyt was particularly concerned with the design of radio panels and suitable mountings. Filters were developed and constructed by T. E. Shea and F. B. Monell; and transformers for various purposes by H. Whittle, D. G. Grimley, and B. W. Bartlett. From the radio engineers of the Laboratories, including those who were engaged in field work, there arose further ideas which were incorporated in the final equipment. Thus protective devices and control methods were engineered by M. E. Fultz, and other contributions were made by Messrs. Schafer and Overacker. Terminal equipment for New York and London was the problem of E. D. Johnson and E. Vroom; equipment layouts of W. H. Bendernagel; and the supervision of wiring, of A. Chaiclin. A continuous evolution of high-power tubes was also proceeding under W. Wilson and M. J. Kelly, with assistance by R. M. Otis, J. R. Wilson, V. L. Ronci, T. McNeill, H. Leuthner, and others, including Thomas Griffith, who went to London to assist there in the manufacture of high-power tubes for that terminal.

The net result of this coordinated effort was new equipment to replace at Rocky Point that used in 1923, terminal equipment for New York and London, and receiving equipment for Riverhead and Houlton in the United States. In the meantime the balance

Mervin J. Kelly

O. D. Engstrom, G. T. Lorance and R. E. Coram



Standing: R. M. Otis and J. R. Wilson; seated: V. L. Ronci and E. J. Sterba

Standing: D. G. Grimley, F. B. Monell; seated, E. Vroom, E. D. Johnson, L. G. Hoyt

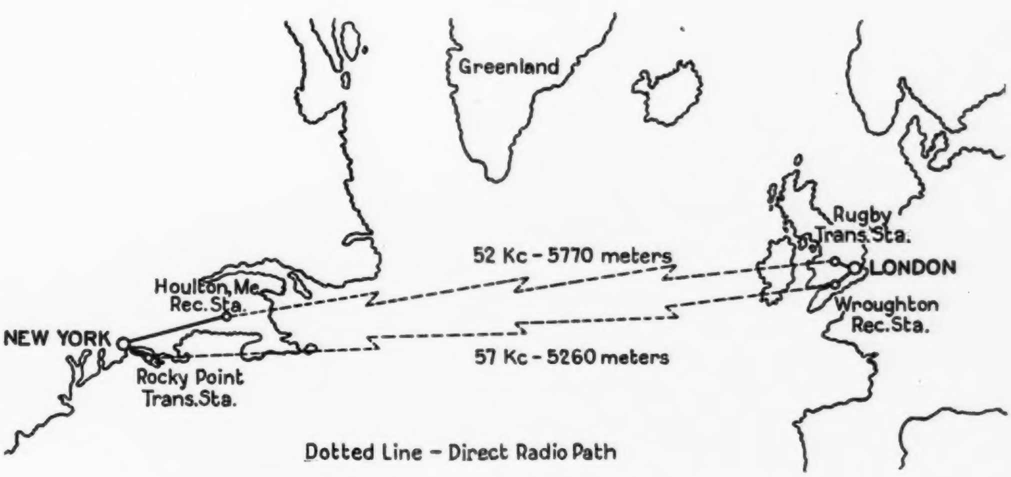
   

H. R. Knettles *T. R. Griffith* *H. E. Overacker* *J. P. Schafer*

of the equipment required in England had been there designed and constructed.

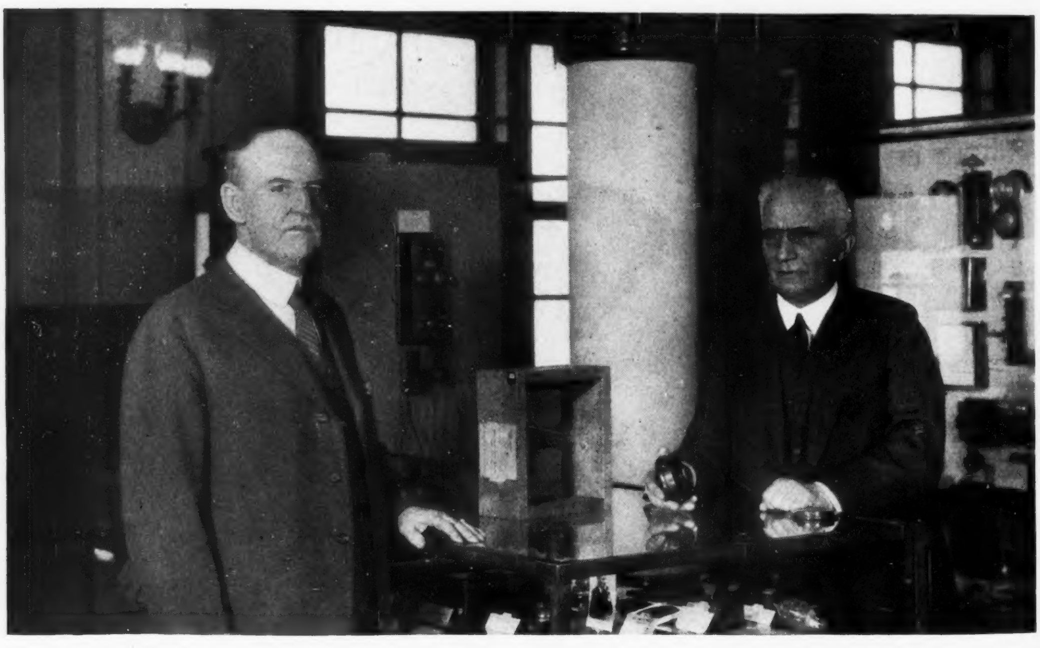
Apparatus, circuits, and equipment conforming to Bell System standards were thus produced to meet the exacting and peculiar requirements of transatlantic radio-telephony with wire-to-radio connection. In the functionalized organization of the research and development work of our Bell System, the Laboratories had performed its appointed task and made its contribution.

The successful experiments on March seventh were due to the efforts of a large number of workers, scientists, and engineers, in England and in America, in the British Post Office, the Radio Corporation of America, and in the American Telephone and Telegraph Company. Large as is the number of men involved, the accomplishment is even larger; for their individual efforts have been amplified by cooperation and coordination. Of the part played in this achievement, fitting to the fiftieth anniversary of the telephone, by members of the Laboratories, their colleagues are peculiarly proud; and they extend their sincerest congratulations.



The paths of the telephone messages across the Atlantic

Professor C. E. Seashore, University of Iowa, a pioneer in audiometric measurements, listens to our audiometer. With him are H. D. Arnold and Harvey Fletcher



Emile Berliner, inventor and one of the early workers in telephony, visits the Museum with Mr. Richards. In Mr. Berliner's hand is one of his early models

From a Black Art to a Science

A Note as to the Attitude of the Modern Chemist

By John Johnston

Sterling Professor of Chemistry, Yale University
Consulting Chemist, Bell Telephone Laboratories

THE alchemist, the ancestor of the chemist, was of the belief that the qualities of a substance could be changed without any fundamental change in the substance itself. He supposed it possible to transmute one substance into another, and to find the universal solvent—though it is difficult to see how he could have kept it if he had succeeded in his quest. He was, or at least pretended to be, a sort of magician; and it was only with the advent of quantitative methods, some 150 years ago, that the subject began to change from a black art into a science, into a body of more and more organized knowledge. Many people, however — and many who should know better—are imperfectly aware of this change; they still look upon a chemist as a magician who with incomprehensible jargon and odoriferous manipulations puts a spell upon things and moulds them to his will. They expect him to do anything from removing stains or assuring the potability of Scotch to producing a metal which shall be lighter than aluminum, yet stronger than steel or an impregnating compound which can be melted in but not out.

This situation is due in part to the chemists themselves, many of whom have adopted an esoteric attitude; but it is due more to the fact that chemical science has so often been presented as if it were a random aggregation of separate facts. Now the chemist is, it is true, swamped with facts, as may be inferred from the circumstance that he has prepared and described more than one hundred thousand individual substances; but this knowledge is slowly, very slowly, being correlated by the discovery and application of definite principles or laws. Perhaps *the* basis of chemistry is that the properties or qualities of a substance depend upon its constitution or structure, just as in the case of an animal or building; hence that any change in structure implies some change in qualities, and conversely.

From this it is evident that the chemist may be regarded as a molecular architect and engineer, who designs and builds structures capable of meeting certain specifications, provided that they are compatible with the structural materials at his command. He can make bricks without straw, but not without clay; or a silk purse from a sow's ear, these things being inherently more alike than they are in outward appearance; but he cannot make gasoline directly from water or create available energy. As an architect he must know the qualities which each of his various structural units — atoms, molecules, radicles—will impart to the finished structure, and learn how these may be combined, before proceeding to build a regular skyscraper of a compound

such as is many a coal-tar dyestuff.

In this connection it may be remarked that the so-called coal-tar or aniline dyes bear about the same relation to coal-tar or aniline as a steel battleship does to a heap of iron ore, the latter being merely the raw material from which the former is fashioned. Moreover, an artificial or synthetic substance is no imitation or substitute, but is the real thing, and indeed is often purer and better than the natural product. Synthetic indigo is real indigo and a synthetic ruby is a real ruby—the only difference being that one is produced by what we are pleased to call natural processes, whereas in the other the process is controlled so as to yield a pure product.

Chemistry rests ultimately on the results of analysis, of breaking down materials into their component units as a means of learning what these are and how they are combined and arranged; but the center of attraction has long moved from the purely analytical side to the synthetic side, towards learning how actually to build up new materials with specified useful properties. An analytical laboratory is needed as a tool in the routine control of the quality of materials; but it tends always to take a smaller direct part in the development and improvement of materials. This is the real business of the chemical department—to discover materials or combinations of materials, for the economical construction of electrical or mechanical devices such that these devices shall have a long life, during which there will be small need of a physician; and also to diagnose and, if possible, to cure the ills to which tools are heirs. Even in a very partial and unsatisfactory achievement of this object one is led back to fundamental questions, to many of which there is at present no good answer, nor any probability of one except through long-continued and painstaking research. For in this rich field we of today have no more than scratched the surface in a few places, and its cultivation will yield crops of knowledge which will make our present stock look as does the knowledge of a century ago as to electrical phenomena.

Technical development has, in a sense, overtaken scientific progress, and its rate is likely more and more to depend on the rate at which the frontier is pushed forward. For this frontier many secure a passport, duly visaed by some university; of these only a few feel the romance of the quest or have the real spirit of the explorer. How to increase this number is a question more easily asked than answered, which reduces largely to a question of social recognition of such pioneer work. In the meantime let us hold aloft the torch as best we may, encourage the extension of knowledge, and thereby consolidate our powers.

Textiles for Insulation in Telephone Equipment

By Howard H. Glenn

OUR central-office switching systems depend for their operation on vast numbers of copper wire conductors, each of which must be electrically insulated. It is in this function of insulation that textiles play their important part. Four million pounds of silk, cotton, and wool are used every year in the telephone plant for insulating wires.

There are two general classes of silk in use, known as "cultivated" silk and "wild" silk. Cultivated silk is obtained from the cocoons of silkworms feeding on mulberry leaves on plantations devoted to silkworm culture, and is commonly used in the manufacture of high-grade silk cloth; wild silk is produced by other varieties of silkworms which are apparently not capable of being controlled and cultivated. Certain varieties of these "wild" worms feed on oak leaves, while others feed on the leaves of the castor-oil plant and fig tree. Wild silk is generally known by the trade-name "tussah," and is the material used in weaving pongee silk. Tussah silk is cheaper than cultivated silk because the fibres are much coarser and are much more difficult to bleach and dye. But as its electrical properties are good, it is widely used in its natural color as an insulating material, particularly where it will be subsequently covered by a secondary insulation. A form of cultivated silk is extensively used, however, which compares favorably in cost with tussah silk. It is known as "spun silk," and, as the name implies, is made by twisting relatively short silk fibres together in the same manner as cotton thread is made. The short fibres are obtained from punctured cocoons—that is, cocoons from which the moth has been permitted to emerge, and from cocoons which for various reasons cannot be unwound. Breakage and wastage in the preparation of long-fibre silk also result in a substantial accumulation of short fibres. Its electrical properties compare favorably with those of long-fibre silk, and in the form of a braided covering such as the brown silk covering of desk-stand and receiver cords it is durable and attractive, as well as economical.

Cotton fibre consists of the seed hairs of the cotton plant, a shrub which grows in most semi-tropical climates, reaching a height of four to six feet. There are a number of varieties of the plant, of which Peeler, Sea Island and Egyptian are the more important. Peeler is the most familiar since it constitutes the bulk of the cotton grown in the United States, and is used generally in the manufacture of ordinary cotton cloth such as muslin and calico. Its fibres or seed hairs are relatively short as compared with either of the other varieties. Sea Island is particularly valuable because of its superior fibre length, strength, and fineness, which permit spinning to much finer yarns than is possible with Peeler cotton; consequently it is used in the manufacture of high-grade fine-texture cloth,

such as "Broadcloth" and the higher grades of mercerized cotton cloths. The fibre lengths of Sea Island cotton range from about one and a half to two inches, as compared to about one inch for Peeler. Egyptian is also a long-fibre cotton, but not quite as long or as fine as Sea Island, the average being about midway between Peeler and Sea Island.

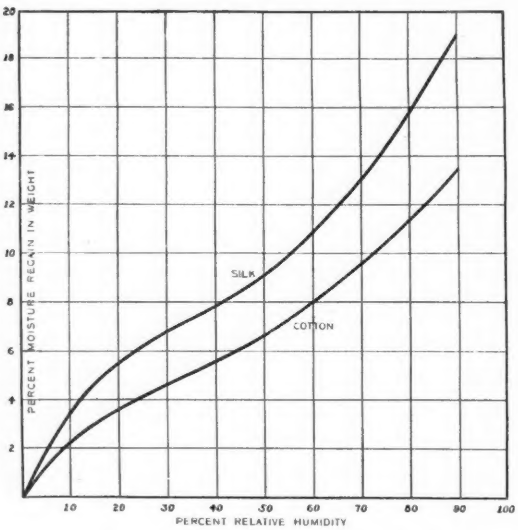


Fig. 1—Comparative moisture-regain in weight of silk and cotton insulation

For insulating wires and flexible conductors, cotton threads are required in various colors and sizes. The range of sizes for this purpose reaches from a thread averaging 6700 yards per pound to a thread spun so fine that a pound of it is over 100,000 yards in length.

It is, of course, generally known that wool is an animal fibre which is capable of wide application in the textile industry. Its use as an electrical insulator is usually confined to conductors where insulation of the same order of value as silk is required, but where conservation of space is not of first importance.

In addition to the foregoing materials, various other fibres such as ramie, mohair, rhea, hemp, jute and artificial silks, have been considered from time to time as possible insulating textiles, but, all things considered, have not yet shown any particular promise of being economical substitutes in electrical insulation for silk, cotton or wool.

Silk and cotton are used singly and in combination to wrap wires throughout their length so that they may be packed tightly and systematically together in cables without short circuits or serious current-leakage between the the wires. In cables the outer wrapping of each wire is applied in such a way that various color combinations are obtained, which make possible color schemes for wiring diagrams. Each group of wires forming a cable is surrounded with cotton wrappings and woven cotton covering as a further protection. Switchboard cords are insulated by wrappings of silk and braidings of cotton and owe their flexibility and ability to withstand continued handling to the use of cotton threads in the tinsel structure of the conductor. Braided spun-silk and cotton coverings are used in the construction of the highly flexible cords used with operators' headsets and in the cords used on subscribers' desk-stand sets. Wool insulation in the form of braided coverings also is used on certain types of cords, and in still other types impregnated wool wrappings covered with mercerized cotton are used to combine with great durability protection against the moisture of the tropics.

For a discussion of the electrical characteristics of textile insulations it should be recalled that there is no perfect insulator, and that this is especially true of textile insulations.

Wherever an electrical potential exists between two electrical conductors which are held apart by coverings of silk, cotton or wool, a certain amount of current may flow through the insulating medium.

Cotton and silk have radically different electrical characteristics, particularly with respect to their behavior under moist atmospheric conditions. Figure 1 shows typical moisture-regain curves for these two materials. By this is meant the percentage increase in weight from a bone-dry condition upon exposure to air at different relative humidities. These curves indicate that silk absorbs more moisture from the atmosphere than cotton, which would lead one to expect that cotton would be a better electrical insulator than silk. Figure 2, however, shows how a pair of cotton-insulated wires actually compare with a pair of silk-insulated wires in respect to their relative power losses (expressed in transmission units) when carrying voice-frequency currents under various atmospheric conditions. Under conditions below seventy per cent relative humidity, cotton is not markedly inferior to silk; but as the moisture content of the air increases, the leakage of current increases more rapidly in cotton than in silk, until at a relative humidity of about ninety per cent. the power loss in cotton insulation is of the order of three times that in silk. Wool insulation behaves much like silk, while vegetable fibres (like linen, jute, or hemp) follow closely the general characteristics of cotton.

In order to decide what textile or what combination of textiles shall be used for insulating a given conductor it is of course necessary to take into consideration the electrical-circuit conditions which the conductor will be expected to meet. In addition the cost, appearance, and ability to withstand various climatic conditions and mechanical abrasion must be considered. For example, the external covering of our standard deskstand cords is expected to present a neat appearance and withstand a reasonable amount of wear. The conductors must be insulated well enough to prevent current-leakage to such an extent that electrolysis of the delicate metal ribbons of the tinsel will not occur within the usual life of the cord. To fulfill all of these conditions, spun silk is used for the external covering in the form of a braid. It has good appearance, flexibility, resistance to wear, and excellent electrical properties. The individual conductors are insulated with a braid of spun silk. This combination of cotton and silk is

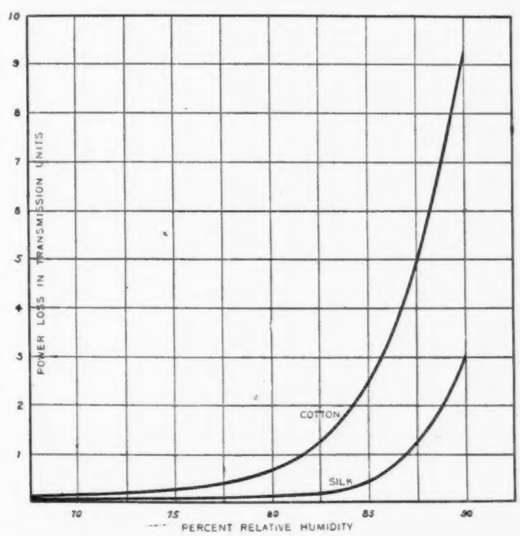


Fig. 2—Comparative power loss, in transmission units, of silk and cotton insulation

used because tests and experience have shown that while two coverings are required for mechanical protection of the conductors, and two silk coverings are not required from an electrical

standpoint, two cotton coverings would permit excessive current leakage.

Switchboard cords present quite a different problem. They are subjected to continuous hard service, and must have coverings exceptionally resistent to wear. This calls for the use of a hard-finished, heavy cotton-covering, which sacrifices to a certain extent both flexibility and insulating properties. The increased stiffness is an objection that in the present state of the art must apparently be tolerated, but the poor insulating properties are avoided by applying a double wrapping of tussah silk immediately over the tinsel conductors and impregnating these wrappings with a moisture-repelling compound.

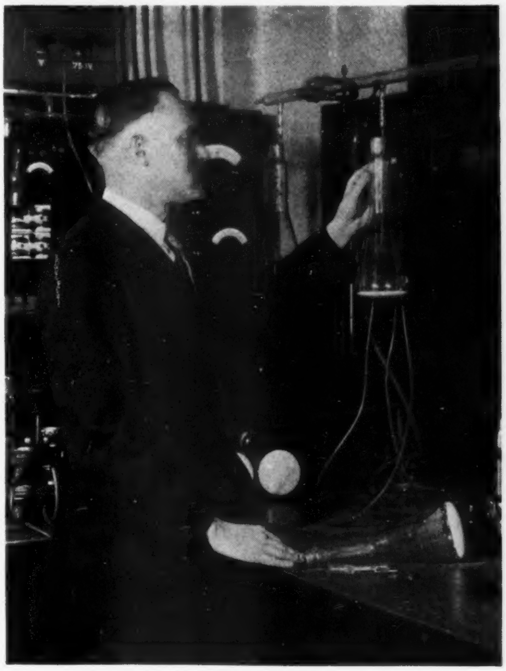
The insulation of central-office cables is another distinct problem. Flexibility is not a requirement, and appearance is not of particular importance. On the other hand, the space factor of the insulation is important, and must be given equal consideration with its electrical properties and cost. Furthermore, the electrical considerations are somewhat different in cable than in cords for the reason that the relatively great lengths of cabled wire in each talking circuit would result in serious transmission losses if the energy loss were permitted to reach the maximum-per-unit-length which is permissible in cords. Before enamel insulation came into general use, the usual switchboard-cable wire-insulation consisted of two wrappings of silk and one wrapping of cotton, the silk being required to prevent undue loss. With the adoption of enamel-insulated wire it was found possible to secure the required insulation by means of the enamel and a double-cotton wrapping, thus effecting a substantial saving in cost by eliminating the use of the expensive silk. However, the double-silk and single-cotton insulated wire is still used to a considerable extent for short lengths of wire or cable because of greater ease in making soldered connections than to enamelled wire.

We are continually studying the properties of textile insulating materials, both in their natural state and when subjected to physical or chemical treatments which may be expected to improve their characteristics. Studies are conducted under the varying conditions to which the insulation may be subjected in service. Much is being learned, and accordingly we may expect that presently there will be new combinations of textiles and improved methods of applying them to conductors, which will either improve the insulation at no increase in cost, or reduce the cost of maintaining the present quality.

Some Uses of the Cathode-Ray Oscillograph

By J. B. Johnson

The Western Electric Cathode Ray Oscillograph Tube, or No. 224-A Vacuum Tube, is one of the younger developments of our Laboratories, which has earned a reputation for usefulness. The essential element of the instrument is the jet of electrons which is generated at one end of the tube and strikes a fluorescent screen at the other end. This jet, which can be deflected by electric or magnetic fields, serves the purpose of a pointer. A bright spot on the fluorescent screen indicates the position of the end of this pointer, and therefore the magnitude of the electric or magnetic fields which are being measured. Being almost without mass and restoring force, the jet pointer can follow faithfully very rapid changes in the field which deflects it. It is this property which makes the tube a valuable high-frequency measuring instrument.



Cathode-ray oscillograph being exhausted. H. W. Weinhart at the left

When, for instance, the alternating current from a transformer, deflects the jet along a line in one direction, say up and down, and at the same time another source of current deflects it from left to right uniformly with the time, then the spot traces on the screen the wave shape of the current, much as does an ordinary oscillograph. Although called an oscillograph, the 224-A tube is something more; it is, broadly speaking, a high frequency curve-tracer which, besides performing the service of an oscillograph over an increased range of frequency, can be used for purposes lying entirely out of the field of the electro-mechanical oscillograph. For example, if, instead of giving the jet a deflection proportional to time, it is moved in the left and right directions by the voltage across the transformer terminals, then the spot traces the current-voltage curve of the transformer. This principle can be used in a diversity of measurements, and in its function as a cyclic curve tracer the tube is sometimes referred to as a cyclograph.

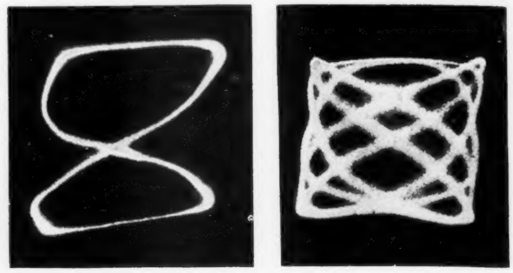
It is the purpose of this note to give some illustrations of how this simple electronic device is saving time

and extracting new information both in our Laboratories and outside. In one of its early uses as a curve plotter the cathode-ray tube was employed to reproduce the cyclic magnetization-curve of ferro-magnetic materials. The technique of the method has been so perfected, in part by Eugene Peterson, that it is now possible to see an accurate hysteresis

The cathode ray oscillograph tube

diagram of a sample of iron in fewer minutes than hours are required for getting the same diagram by a ballistic galvanometer method. Furthermore, any changes in the magnetic properties can by this method be followed continuously as they occur.

The tube has also contributed importantly to our art of frequency measurement, especially in the hands of John G. Ferguson and William A. Marrison. The beat-note method of comparing the frequencies of electrical currents has been largely replaced by the method in which the motion, or rather lack of motion, of a Lissa-



Lissajous' figures: Left, frequency ratio 1:2; *right, ratio* 4:5

jous' figure on the screen of the oscillograph tube indicates the frequency ratio of two oscillators to almost any desired degree of accuracy. It is, for instance, possible to compare to within a few oscillations per second the frequency of WEAF with that of the 100-cycle tuning fork which, next to the time signals from the Naval Observatory, furnishes our standard of time.

Another application of the tube to the control of high-frequency circuits

Oscillogram of high frequency oscillator, fundamental frequency 100,000 *cycles*

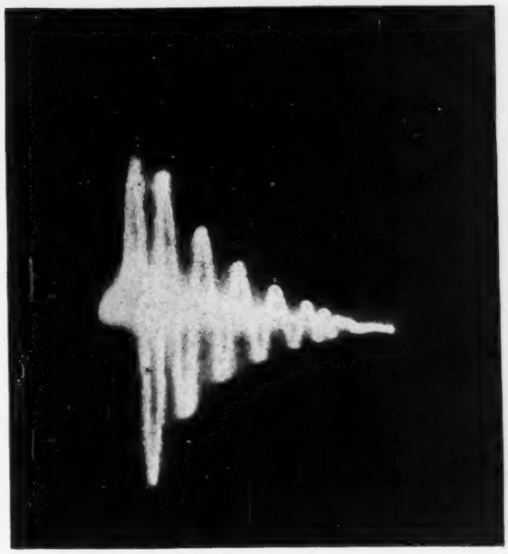
is that of the measurement of the modulation of a radio transmitter. John C. Schelleng devised the method whereby the tube shows at the same time the amplitude of the low-frequency modulating-voltage and the

high-frequency modulated output-current of the transmitter.

Many of us use the cathode-ray tube as a general laboratory instrument for whatever measurement the moment happens to demand. William A. Knoop, using the oscillograph tube as the indicator, measures the accuracy and regularity of synchronizing and printing impulses in studies of high-speed telegraph apparatus with little more trouble than if he were measuring a simple resistance. What is still more interesting, David G. Blattner has applied this versatile instrument to the solution of problems of the heart. He has combined the tube with the electrical stethoscope, described in a recent number of the RECORD, in such a way that the examining physician and his students can see as well as hear the heart's murmurings and palpitations.

Hysteresis curves of permalloy (65% nickel, 35% iron), with and without tension

Originally the tube was developed to satisfy the needs of our own laboratory for such an instrument. Nevertheless, there has developed a considerable demand for the tubes from outside, which we have tried to satisfy. Reports are appearing in the scientific and engineering journals of the use of the tube in various fields. Professor K. T. Compton and his students have used the tube in their studies of electric conduction in gases. The radio engineers of the American Telephone & Telegraph Company and the staff of the Radio Research Board of the British Admiralty have found the tube a valuable instrument for studying static. Physiologists have employed it to trace the course of nerve impulses, power engineers to chart corona losses on high-voltage lines, and automobile engineers to ascertain the operating characteristics of ignition systems.



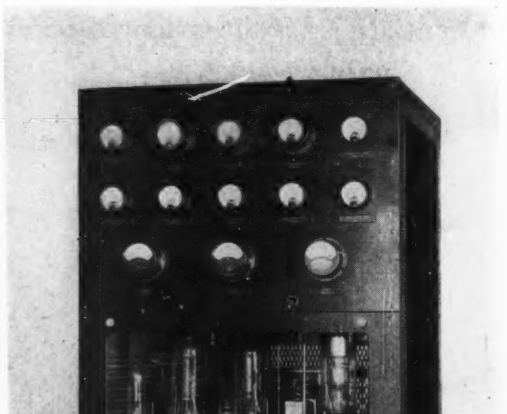
Oscillogram of a condenser discharging through inductance and resistance

The oscillograph lends itself also to demonstrating various elementary phenomena in electricity and magnetism, and many colleges have added it to their demonstration equipment.

A One-Kilowatt Radio Transmitter for Broadcasting

By Arthur W. Kishpaugh

WITH increasing demand for better service to the broadcast listener, it is probable that the use of inadequate transmitting equipment will be largely discontinued. Between the extremes of too small power on the one hand and costly high-power installations on the other there is a field where the requirement is to serve well an area of moderate size. It is for this field that the 6-A Radio Transmitter is especially suitable; it has an output of one thousand watts and requires a space comparable to that which has been used for installations of five hundred watts. Another important part of its design is the incorporation of developments in the art other than those touching on power.

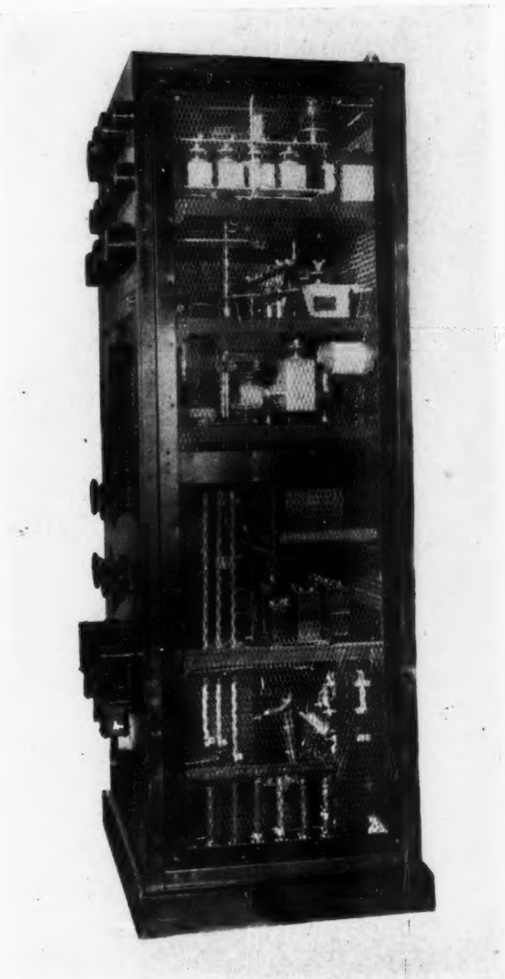


Front view of the 6-A Radio Transmitter

The construction of the radio transmitter itself is shown in the accompanying photographs. It is approximately thirty-four inches wide, twenty-nine inches deep, and six feet ten inches high. The view of the front of the transmitter shows its appearance when in use. The four principal vacuum tubes may be seen through the window near the center of the panel. The controls below this window include those for ordinary tuning of the radio frequency circuits and those for controlling the power equipment. The motor-generators which supply power to the transmitter are started and stopped by means of the push buttons provided, and the voltages of the generators are controlled here by means of field rheostats. Thus it will be seen that the transmitter includes the power control equipment as well as the ordinary radio transmitter circuits, doing away with the necessity for a separate power-control panel. The unit here pictured is all that is

Safety switches on the door and window in the front panel guard against the motor-generator sets being operated with either open, thereby protecting the operator from coming in contact with high-voltage circuits.

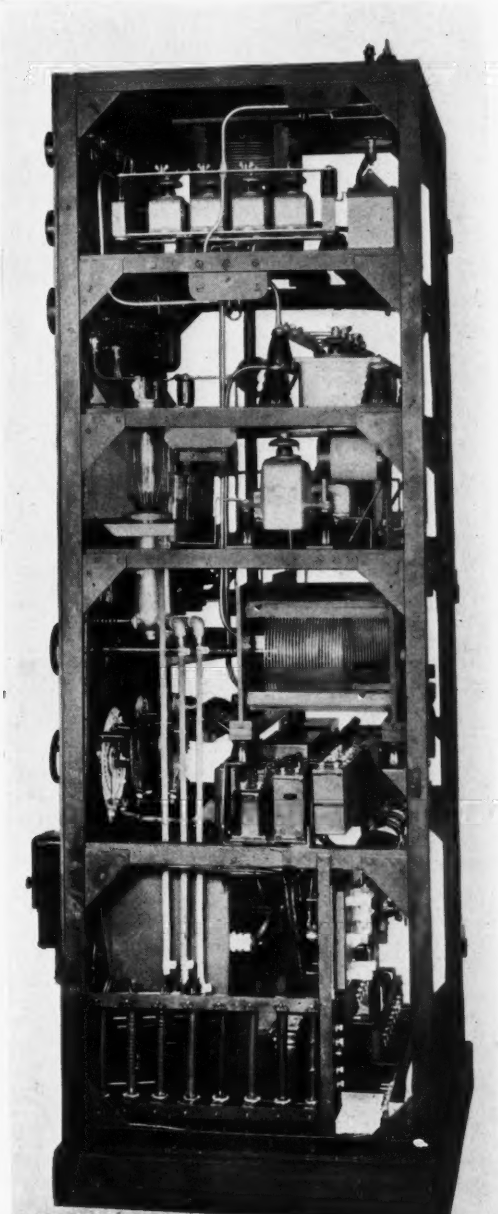
Neatness and compactness of inte-



Side view, with screen in place

required for radio transmitting in addition to the power-supply apparatus which is ordinarily installed in some other part of the station. Both installation and operation have been greatly simplified by this design.

The side view of the transmitter with the screen on shows the method of enclosing the circuits and, at the same time, having the apparatus inside visible for inspection. The entire back of the transmitter is enclosed by means of a similar screen in the form of a door, which affords ready access to all parts requiring adjustments not made from the front of the panel.



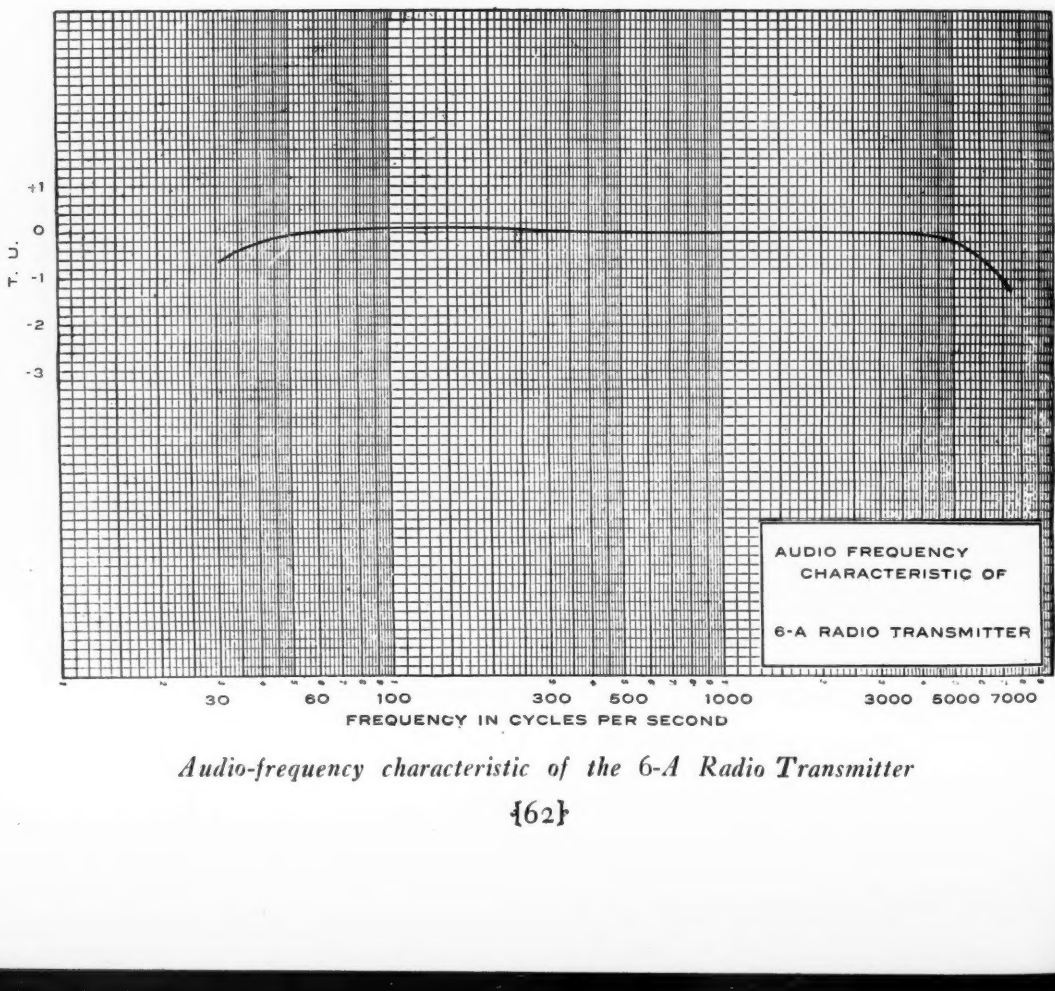
The side of the transmitter, with screen removed

rior arrangement are features of the 6-A radio transmitter. Near the center and to the rear may be seen two of the radio frequency coils with controls extending from them to the front of the panel. Most of the radio-frequency circuits are located above this point, the antenna tuning coil being near the top. The space in the lower part is largely taken up with power-supply and the control circuits. Terminals for making connections to the transmitter are shown at the back near the bottom. The principal vacuum tubes are mounted just back of the window near the front of the transmitter.

In the foreground a tube of the water-cooled type and the vertical rubber tubing connections for conducting cooling water to and from its jacket may be seen. It is necessary that the cooling water be conducted through insulating tubes, since the water jacket is at the same potential as the anode of the tube.* A voltage of 4000 is used on this vacuum tube, and it is called upon to deliver, during modulation, peaks of power of the order of three kilowatts. Thus a greater amount of power is controlled than is indicated by the rating of one kilowatt, which represents the normal unmodulated output.

The output of this water-cooled tube, which acts as a radio-frequency amplifier, is delivered to the antenna through a coupling which practically prevents the radiation of harmonics. This is a very necessary feature since, with the increase in the number of broadcasting stations and the power used, the interference due

** A flow-operated relay to protect this tube was described in the* RECORD *for February, 1926, pp. 251-254.*



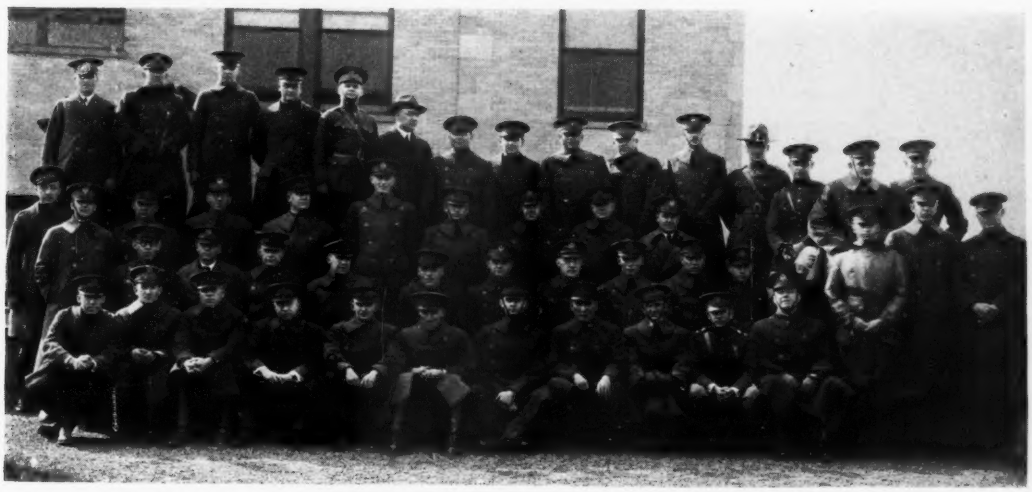
Audio-frequency characteristic of the 6-A Radio Transmitter

to harmonics would become increasingly troublesome if their radiation was permitted.

Power for the transmitter is obtained from two motor-generator sets which may be equipped for operation from almost any type of power supply, so that possible application of the equipment is universal.

Naturally, the quality of the service rendered by a broadcasting station is judged largely by the tone quality of the received programs. In order to have faithful reproduction, it is necessary that the many frequencies to which the ear responds be transmitted with the same relation to one another that they had before the microphone. To this end particular attention has been given to the audio-frequency characteristic of the 6-A Transmitter. The results achieved are shown in the accompanying graph; it will be noted that the transmission between 30 cycles and 7000 cycles is extremely uniform.

The 6-A Radio Transmitter is one of our principal contributions in radio-telephone broadcasting equipment during 1925. It has been taking its place creditably, but so quietly, that many will be surprised to know that twenty-six have been purchased during the past year for installation in the United States and eight for shipment to European purchasers.



Fort Monmouth officers who recently visited the Laboratories. In upper row is George F. Fowler, who had charge of the details of their visit

Early Models of the Telephone

By Wilton L. Richards
Consulting Historian

THE grouping of pictures on the opposite page was displayed on all bulletin boards of the Laboratories on March tenth. Some notes as to these pictures are here recorded.

* * * * *

In the early part of 1875 Alexander Graham Bell was at work on a "voice frequency carrier" telegraph system. His models were made in the shop of Charles Williams, Jr., at 109 Court Street, Boston, by a young mechanic named Thomas Augustus Watson.

* * * * *

In June, 1875, one of his experiments suggested to Mr. Bell the solution of another problem which he had been turning over in his mind for some time. Next day a model had been made up and speech sounds were heard over a wire, but not understood. The transmitter was of the form shown on our Service Emblem, and is generally known as Bell's First Telephone. The receiver was of the tuned reed type, pictured on the opposite page.

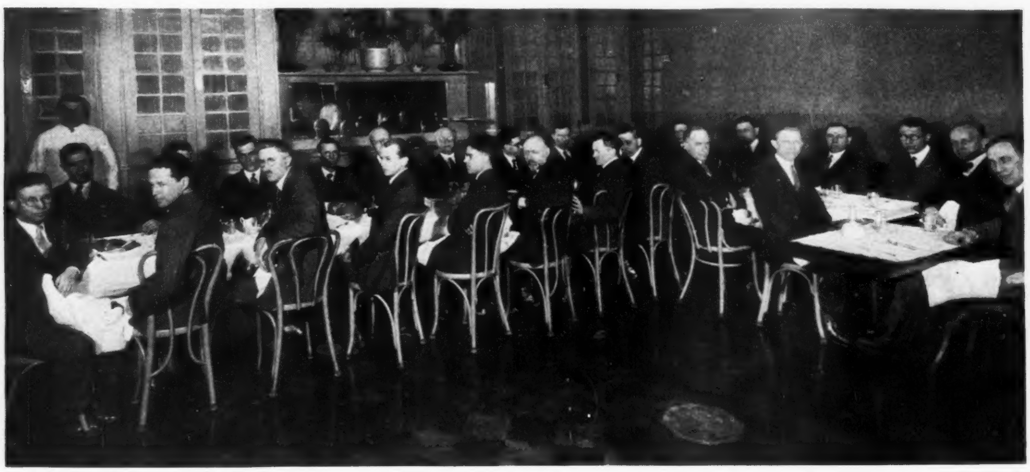
* * * * *

Three years later further tests were made with telephones of a type similar to that which transmitted these first articulate sounds. When two of these instruments were set up in a quiet place, a conversation was held over the circuit, and Mr. Bell was satisfied that his original devices of 1875 had been entirely capable of transmitting and reproducing intelligible speech. During the ceremonies at the opening of the transcontinental line in 1915, Dr. Bell used a replica of this instrument to transmit the words, "Mr. Watson, come here, I want you," to his old associate who was one of the group at the San Francisco terminal.

* * * * *

During March, 1876, a crude form of local battery transmitter was made up in the Williams shop. Its variable resistance consisted of a platinum rod dipping into a weak acid solution. It was connected to a simple receiver of the form previously used, and tests showed that sounds could be heard. Within a day certain refinements were made to produce the transmitter illustrated, and it was taken to Bell's lodgings at 5 Exeter Place, Boston, for further tests. On March 10, 1876, the now famous words were heard, "Mr. Watson come here, I want you." This first complete sentence to be understood over an electric circuit fixes the date we celebrated last month. On that date in 1876 Mr. Bell had just passed his twenty-ninth birthday, and Mr. Watson was twenty-two. The portraits on the opposite page were made in 1912.

On March tenth, when President Jewett spoke from Vice-President Craft's office to the members of the Laboratories at West Street and Hudson Street. Left to right: R. L. Jones, A. F. Dixon, E. P. Clifford, E. B. Craft, S. P. Grace, J. J. Lyng, F. B. Jewett, J. G. Roberts, H. D. Arnold



This photograph of the Colloquium was taken on the evening of February twenty-seventh, during the dinner which preceded its ninety-sixth regular meeting. Professor Bergen Davis, of Columbia University, was the guest of the evening, and spoke on "The Refraction of X-Rays"

Development of Communication Systems

By Amos F. Dixon
Systems Development Engineer

THE Systems Development Department derives its name from the character of its work. A "communication system," as we use that term, is a combination of electrical and mechanical equipment which is designed for the electrical communication of intelligence. But it means more than that. It involves a commercial and economical combination of equipment and circuits adapted to efficient operation. It is the complete combination, including not only the equipment and circuits necessary for the transmission of intelligence, but all the accessory equipment and circuits essential to the supervision and control or switching of the circuits required for transmission alone. The final design of a system includes also the association of sources of energy for the operation of the equipment, of apparatus for its test and maintenance, and designs for the assembly of all equipment in a manner suitable for economical maintenance and operation.

Since the plant of the Bell Telephone System is in itself a completely interrelated and interconnected assembly of equipment and lines with almost infinite possibilities of interconnection and related operation, we might most justly, perhaps, confine our use of the term "system" to its singular form. By custom, however, we speak of separate portions of this enormous system as individual systems. Thus we speak of a common-battery system, of a manual exchange-system, of panel-type machine switching as a system, of carrier-telephone and carrier-telegraph systems; and since the recent experimental trials we might speak of a transatlantic wire-to-radio-telephone system. Each component system of the whole, even though we may regard it as an individual system, is always, in the minds of the system designers, merely a component of the present and future communication system.

This fact, that each new component system must operate as a part of the whole, is fundamental in the viewpoint of the designer. For the solution of its problems the members of the Systems Development Department, therefore, must have a wide acquaintance with the full range of problems which arise in the communication business. They must have analyzed data concerning the present plant, be thoroughly sympathetic to the trend of communication developments, and be capable of a reasonably accurate prediction of the future. Whatever they design must be a smooth transition between the art of the present and the unknown art of the future.

The requirements which each development must meet are obtained by the Laboratories from the Development and Research Department of the American Telephone and Telegraph Company, and in final analysis arise from the field and operating requirements, both present and future, of the Long Lines Department and

the Associated Companies. To these requirements the Systems Development Department adds its views and past experience. In meeting its problems it has access to data gathered by the Laboratories and the Associated Companies and to much from the past experiences of its members. Its engineers must know about the several kinds of telephone and telegraph traffic and the best methods of handling them in order to design suitable equipment. They must have some acquaintance also with commercial phases because most dealings with the public are in connection with service and such problems must be taken into consideration in developing equipment.

There must be also in the Systems Development group men thoroughly familiar with the problems which arise in outside plant construction, in the construction of buildings and their fire protection, in maintenance methods, and in fact with each of the matters which relate to operating telephone systems. There must also be within the department both a background and a personal familiarity with the manufacturing and installation processes in order that systems which are designed may be economical of manufacture and installation.

Within the Laboratories' organization the work of the Systems Development Department is interdependent and very closely coordinated with the Apparatus Development Department and the Research Department. Much of its work is based upon the results earlier obtained by the Research Department. For example, the carrier-current systems of today and the vacuum-tube repeater systems are based upon earlier developments in the Research Department. The constantly enlarging field of application and the current development of new requirements result frequently in requests for new researches, such as studies of certain aspects of modulation.

The individual pieces of mechanism which enter into a communication system are developments and designs of the Apparatus Department. Such designs may arise from requests for pieces of apparatus to meet specific requirements in order to fit into a system under development, or they may arise from some of the continuous and fundamental development work which is done by that organization. In the latter case they offer to the systems designer new and attractive opportunities for their utilization.

In our closely coordinated work each of us, and each organization of which we are a part, finds in his or its peculiar tasks peculiar satisfactions. In the systems development work we feel that we have a continuing opportunity to produce a part of the greatest communication system in the world; that the things with which we deal are to be seen in operation every day and in every part of the country; and that they stand for us as evidence of our part in the total achievement. Just as better communication between men and communities should develop good will, tolerance, helpful sympathy, and greater understanding, so we feel that the intimate communication which our work permits and requires with other departments and even companies should assist in developing the best in each of us; and within our department the ideal is to form a community of men with ambition, will and ability, technically competent from a broad experience, and with opportunity to achieve distinction, individually and collectively, through the advancement of the communication art.

The Systems Development Department

By Paul B. Findley
Managing Editor

The product of Bell Telephone Laboratories is essentially intellectual. Embodied in the words of specifications and scientific papers, the lines of blueprints, and in the metals and materials of apparatus models are ideas for the advancement of the communication art. Ideas are the output of our organization, and they are also its input—not as raw materials are the input of a factory, but in the sense that small electric currents in the input circuit of an amplifier are the occasion for the much larger current of its output. And just as the difference in power between input and output of an amplifier comes from local sources of energy, so the "gain" in ideas between the incoming suggestion and the completed project represents an intellectual contribution from the experience and ingenuity of our organization.

On account of its many contacts within the Bell System, a large part of the input to the Systems Development Department comes in the form of information as to the needs of the operating telephone companies. Sometimes the need is for a circuit to perform some new function and to work with certain existing circuits. At other times requests come from engineers of the American Telephone and Telegraph Company as a result of theoretical studies or their projection of the future requirements of the Bell System as a whole. New manufacturing methods at Hawthorne, new apparatus developments, or new results of research suggest revisions or entirely new designs.

Let us trace the course of a typical development. Engineers of the American Telephone and Telegraph Company are favorably impressed with a new way of handling certain kinds of telephone calls. The information at their command is passed to the Laboratories, with a request to develop a system for the purpose. Our Systems executives analyze the problem and assign it to the groups or individual engineers best fitted to solve it. After determining what are the most promising fundamental circuits, each is worked out as a schematic drawing, a list of apparatus with their respective electrical requirements, and a circuit description telling the sequence of operations. This information is then gone over by a separate group, who determine whether the circuits will meet the requirements of practical installation and operation with a margin for safety. When necessary, the circuits are actually set up and all operations checked, and if a trial under operating conditions is desirable, an installation is made in a central office. Meantime a careful study is made of comparative costs, to see if the proposed system involves lower annual charges * than any other sys-

* *Annual charges represent the cost to the operating company, including such items as interest on the investment, depreciation, maintenance, power, and rental of building space occupied.*

tem, and to give information to the A. T. & T. which will help them decide whether the proposed operating method represents an economy. A. T. & T. engineers are in touch with the entire development, and when results are satisfactory to all concerned, the complete equipment is standardized for use in the Bell System. Information in the form of manufacturing, installation, and testing specifications goes to Hawthorne, and orders for the equipment are then accepted from the Associated Companies. When these orders require no modifications of the standard specifications, our Laboratories are not consulted further.

In addition to developments of the rather fundamental type outlined above, the Department does a large amount of current engineering work to adapt standard methods and systems to the varied needs of the operating companies. Requests for this service usually come from Hawthorne, as a result of a customer's specifying something which is not standard to meet the special operating or plant conditions in its territory.

An acceptable design for a telephone circuit must satisfy a surprising range of conditions. Without any attempt to indicate their relative importance, it is interesting to name a few. There is the subscriber, who must be able to do his share without too much training or personal effort, and is better satisfied when he can follow some of the steps in setting up the connection. Cross-talk between adjacent circuits must be avoided by proper placing and spacing of the apparatus. The operator must be considered—her arm-reach is a limiting factor in the design of switchboards; how fast she pulls a key-lever determines the interval when, for instance, all contacts of a key are open—a vital point in certain trunk circuits. Then the circuit must be one capable of manufacture and installation at reasonable cost; it must tolerate variations of resistance and other electrical properties within normal manufacturing limits, and adjustments such as relay springs must be those which an installer, not an engineer, can be relied on to make. Maintenance, too, must be considered; mountings must be such that defective units can easily be taken out and replaced. Sometimes lower maintenance charges can justify a circuit whose greater ruggedness entails a higher first cost. Certain limiting conditions will be met in the plant: as for instance the resistance, leakage, or capacitance of connected lines or networks; the available battery voltage, and cross-talk requirements.

Operating features of other circuits impose requirements, especially severe in the case of PBX circuits, which must work with a minimum of changes into either manual or machine-switching offices. Broad economies must be studied, as for instance reducing the number of costly sender units in a machine-switching office by circuits which give a subscriber's line access to larger groups of senders. Other large economies follow from reducing the holding time of expensive circuits such as senders, thus again reducing the number of these required. Finally there is the problem of meeting the closely-timed manufacturing-installing schedules; information must be ready on time, and must be so complete and accurate that Western Electric can go ahead without delay.

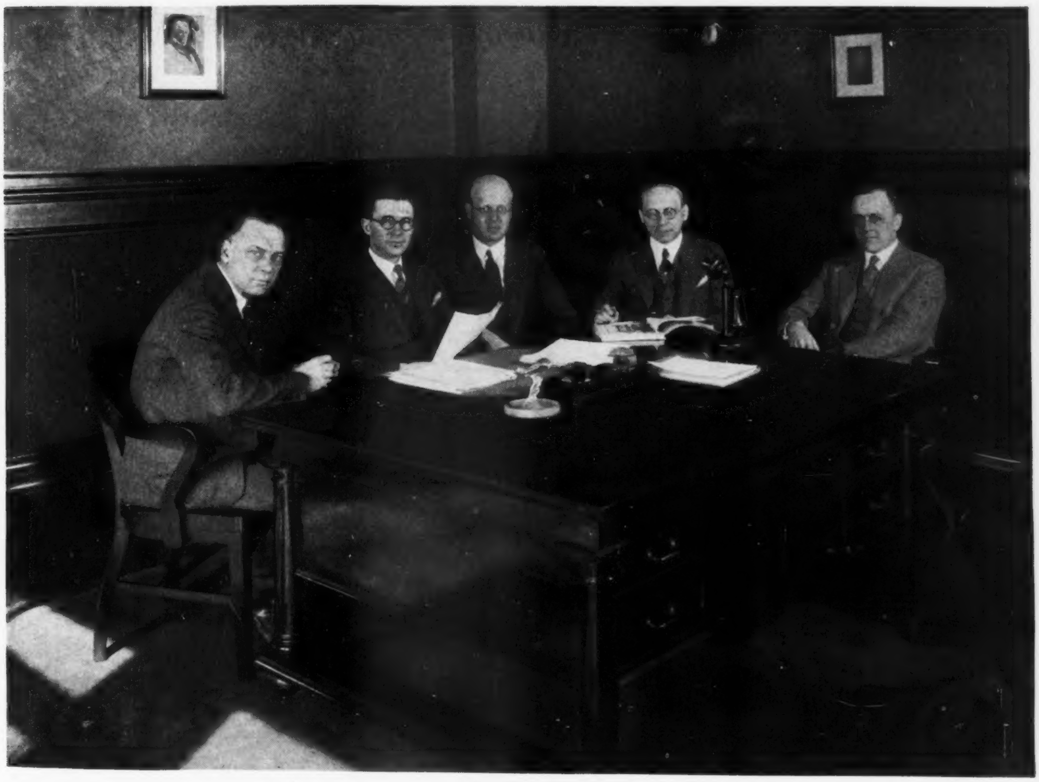
With this picture in mind of what is expected of the Department, let us see how it has organized its eight

hundred men and women to carry its load. Reporting to Amos F. Dixon, Systems Development Engineer, are three men in charge of development groups: W. H. Matthies, central office circuits; B. W. Kendall, toll circuits; and H. H. Lowry, equipment. A fourth group, that of L. Keller, makes cost and other special studies.

Circuits for local central offices are developed by Mr. Matthies' organization; Mr. Kendall's group handles circuits used in toll offices as well as telegraph and other circuits routed over toll lines. In Mr. Lowry's group the apparatus and wiring are assembled into switchboards and frames to form equipment, and these units are further combined to form complete central offices.

When Western Electric came up from Thames Street to our present building, William H. Matthies helped in the moving. Soon he left to enter Massachusetts Institute of Technology, and on graduating in 1902 returned to Western Electric as a student engineer. In 1904 he was sent to Berlin, and later to Antwerp, where he had charge of early work on machine switching. Leaving Belgium as a war refugee, he was for a time in Scandinavia, and in 1916 returned to West Street. For a while in charge of the circuit laboratory, he was later put in charge of local circuit design. In December, 1921, his responsibilities were extended to their present scope, covering both design and laboratory work on local circuits.

One of Mr. Matthies' groups, that reporting to W. L. Filer, designs the



The Telephone Systems Engineer and his staff. Left to right: W. H. Matthies, A. F. Dixon, B. W. Kendall, L. Keller, H. H. Lowry

circuits; another group reporting to J. L. Dow checks these designs either by test or by analysis of the drawings and specifications, as has been outlined in an earlier paragraph. Also reporting to Mr. Matthies is F. A. Stearn, in charge of fundamental studies on machine switching.

Several years of physical research and teaching following his graduation in 1906 from Massachusetts Institute of Technology were the background of Burton W. Kendall when he entered the Research Department in 1913. His early work was on repeaters in connection with the opening of the Transcontinental Line; he was also concerned with carrier development from its inception, and with the Arlington radio telephone tests and the Havana cable. After several months in Europe as a member of the Bell System group studying the technical problems of the Paris-Strassbourg cable, he was placed in charge in December, 1919, of the toll development work of the Systems Department.

Mr. Kendall's forces are divided into three groups. That of J. H. Bell is concerned with all types of telegraph systems. Carrier telephone and all forms of vacuum-tube repeater systems are grouped under C. W. Green. Responsibilities of R. S. Wilbur include circuits for switching and signalling, the handling of requests from Hawthorne for special circuits, and the toll development laboratory.

In 1909 Hiter H. Lowry entered the Western Electric student engineering course at Hawthorne, having been graduated that year by the University of Kentucky. Later he was assigned to the Equipment Branch, becoming in 1918 head of the Equipment Development group. With the concentration of this work at West Street, Mr. Lowry came here in 1919.

Of the six men who report to Mr. Lowry, three supervise development and three engineering service functions. The groups which report to E. J. Johnson for machine switching and C. Borgmann for manual and toll develop the equipment structures and office layouts and plan the economic arrangement of the apparatus as determined by the wiring of the circuits in which it functions. It is their problem to see that the equipment structures are designed to accommodate the proper circuits as determined by the traffic requirements and that the apparatus is well located for economic assembly and easy access for maintenance. They are responsible for the preparation of all the general specifications, questionnaires, and the context of technical information on equipment sent to the telephone companies.

The third development group is that of A. E. Petrie, which is responsible for the power required in the telephone office. Beginning with the primary sources of energy, such as electric and gas company services, these engineers design and specify motor- or engine-driven generator sets to deliver at the distributing fuse-panels all of the varied kinds of electrical energy required for proper talking, signalling and switching in the telephone plant. Among their problems are the insurance of the power supply under all conditions of service, seeing that the talking current is free from noise and cross-talk, the development of methods of control to insure minimum variation in the character of the supply as well as the actual design of the power equipment itself.

The Current Development group reporting to S. F. Butler furnishes

Hawthorne with the information necessary for the manufacture of any special features desired by our customers; they also analyze the more complex jobs when requested, to insure that proper equipment is furnished. Information is secured from the A. T. & T. and the customer, as may be necessary, and the appropriate groups at West Street are called on for the necessary design work. Another group reporting to Mr. Butler handles trial installations, preparing the job specifications and drawings from which the trials are built, arranging for their manufacture, and supervising their installation in the field.

The work of the equipment drafting room was described by R. Petersen, its head, in the RECORD for February. Handling, indexing and distributing the large number of tracings, specifications and drawings prepared in the Systems Department as well as equally large quantities of similar technical information received from the telephone companies and the Western Electric for reference purposes in the department is the principal work of the groups reporting to W. L. Heard. Methods of handling this work efficiently and departmental costs and clerical work are also under the supervision of Mr. Heard.

After many years' experience in manufacturing, installing and operating the Automatic Electric Company's telephone apparatus, Leo Keller became a Bell man in 1917, when the two systems in Los Angeles were consolidated. In January, 1918, he was transferred to the Laboratories. Mr. Keller's group makes fundamental studies of systems not only in use or proposed by Bell System engineers, but also systems of other companies in America and abroad. These studies include basic cost information which aids A. T. & T. engineers in arriving at annual charges. In addition, the operating features of other companies' systems are investigated from the point of view of their effect on the art in general and the Bell System in particular. Another function is to assist other groups in the Department to determine the most economical lines of progress. Of Mr. Keller's staff, S. B. Williams makes systems studies, and does such incidental circuit work as may be needed. E. E. Hinrichsen studies patents and their effect on the Department's work; E. D. Talbot supervises equipment engineering and cost estimating for theoretical studies; H. L. Bostater handles costing and pricing; and C. L. Goodrum makes special studies.

John Fritz Medal Award

Edward Dean Adams, engineer, financier, and scientist, a pioneer in the development of hydroelectric power at Niagara Falls, was awarded the John Fritz medal by the Engineering Foundation at its meeting of March thirtieth. President Jewett, of Bell Telephone Laboratories, as Chairman of the Board of Award, presided at the meeting.

A Conference of Inspection Interests

On February 25 and 26 Bell Telephone Laboratories was the scene of a conference on the subject of apparatus inspection, with particular emphasis on methods for ensuring the control of characteristics so that the product should be economic both for manufacture and for use in the telephone plant. The conference reviewed the results of inspection surveys which have been made jointly by the Laboratories and the Western Electric Company during the past two years, and mapped out future plans and objectives for this work, particularly in the direction of applying statistical principles to inspection methods and to the interpretation of inspection results.

This conference was unique in the diversity of interests represented. From Hawthorne Manufacturing Inspection came W. L. Robertson, Superintendent of Inspection, S. M. Osborne, and several others of the Control Inspection Division. Representing Western Electric Company Inspection Department were E. D. Hall, recently appointed Superintendent of Inspection Development, J. A. Davidson and others of the Check Inspection Division at Hawthorne and Kearny. The Kearny Works was represented by F. A. MacNutt, Assistant Works Manager; the Philadelphia Instrument Shop by D. A. Wallace, Superintendent, and T. M. Erickson, Assistant Superintendent. Inspection of telephone apparatus and materials of other than Western Electric manufacture was represented by F. D. Thompson, Sales Inspection Superintendent. Messrs. A. J. Lawrence, E. S. Dibblee and M. McCallum, of the Northern Electric Company, were visitors. Present from the Laboratories were J. J. Lyng, Apparatus Development Engineer, A. F. Dixon, Systems

Those who attended the Inspection Conference

Development Engineer, and members of the Inspection Engineering Department.

R. L. Jones, Inspection Manager, was general chairman of the conference, with D. A. Quarles, head of the Apparatus Inspection Department, as vice-chairman in charge of the presentation of papers and discussion. Papers on the results of cooperative survey work were read by S. M. Osborne, of Hawthorne, and R. M. Moody, of the Laboratories. Statistical aspects of inspection problems were discussed in papers presented by J. A. Davidson, of Hawthorne, and Messrs. Shewhart and Dodge, of the Laboratories. W. L. Robertson and D. A. Quarles read papers on plans and objectives of the cooperative survey work. Time was allowed for full discussion of the issues raised by the papers and a number of plans for extending the scope of the work were developed.

K. B. Doherty acted as business manager of the conference, and in addition to arrangements for the business sessions provided an excellent dinner and theatre party for the evening of the first day.

General Engineering Circulars

By Margaret K. Staab

"WHAT is the A. T. & T. standard practice?" is a question that the Information Files of the Laboratories are frequently called upon to answer. To provide a ready answer, one entire file is devoted to the care and distribution of the circular letters, bulletins, notes, specifications, and hand-books which are distributed to Associated Companies to keep them informed of new apparatus and methods.

The present series of these publications was started in 1905 with a circular on central-office equipment; and the latest one received has to do with night bell circuits of the No. 9-C switchboard. While some of the earlier letters in the series dealing with manual telephone equipment and the methods and practices of the day were relatively simple, the circular letters of the present are often issued in book form with as many pages as are needed to explain the latest developments of the art.

Our files, which are complete for the last twenty years, include more than two thousand such publications. In many of them occur the words "improved" and "redesigned," indicating the constant technical progress.

Each publication as it is received is analyzed and all subjects of present or probable future interest are carefully indexed. For example, a circular letter covering "local operating room desks" will be given in the index a card for each type of desk which is there listed as standardized. An elaborate index of approximately fifteen thousand cards has thus been built up so the department, through its use, may locate for engineers the information they need. Every two weeks a list of the new publications is compiled and distributed to all those who will be concerned.

How the Laboratories are Heated

By H. B. Van Zelm

STRUGGLING from the subway these spring mornings and suddenly finding ourselves pursuing our elusive hats along Bethune Street—or plugging north from Christopher Street to arrive at 463 with red noses and copious "tears"—we accept without contradiction the statement that our building presents an unusually severe exposure to the elements.

The prevailing winter winds, sweeping across the Hudson from the northwest, split on the corner of the building and "scour" both faces, not only jamming ingress (in spite of thorough weather stripping and the most modern steel sash), but also sweeping away the film of warm air which in quieter surroundings clings to the outer surface of walls and forms an insulating blanket. Under these conditions the demands on our heating plant are very severe, and great flexibility of operation is necessary in order that an inside temperature of 70 degrees F. may be maintained regardless of sudden changes in wind direction and outside temperatures.

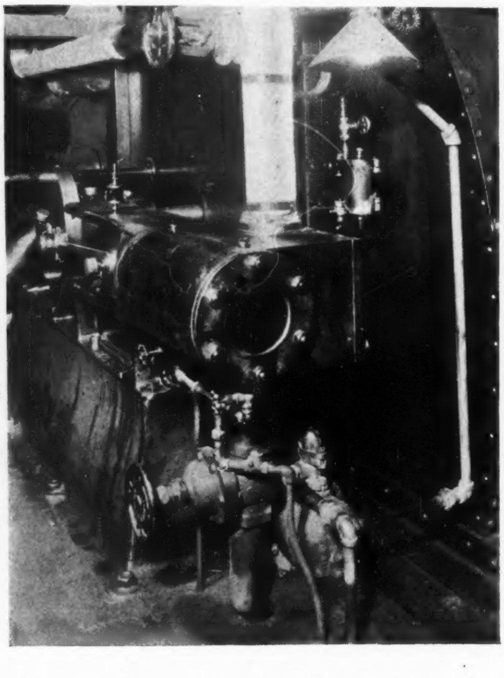


Fig. 1—One of the hot-air hearing units

Realizing this, the Plant Department maintains a sort of local weather bureau, observing every two hours throughout the day the temperature at the roof, the direction and velocity of the wind, and temperatures in all parts of the building. This information is entered in the power room log and posted on a chart in the office of George F. Morrison, Power Engineer. From this data the operation of the heating system is regulated.

In our plant two different mediums for distributing heat are used—air and water. Sections B and C, the first two buildings to be erected, are heated by hot air through what is known as the "hot blast" system. Cold air from outside is drawn in through a heater by means of a fan and distributed through ducts in the building at a temperature sufficiently high so that in dropping to 70 degrees F. enough heat will be given up to replace that lost through the building walls. Regulation in such a system may be obtained by either varying the amount of air introduced, varying its temperature, or by a combination.

Sections B and C have each a sep-

arate hot blast system, to which air is admitted from the east end of the main court. The heater consists of a large steel box about eight feet square and six feet long, open at both ends, and containing several hundred feet of coiled pipe so arranged as to permit steam to be turned into all pipes or only a portion. By manipulating these valves the final temperature of the air may be controlled. Air is drawn through the heater box by a huge steel-plate fan, which consists essentially of a scroll-shaped housing in which revolves a big paddle wheel. Power to operate this fan is supplied by a small direct-connected steam engine, which takes steam at the full boiler pressure of sixty pounds and exhausts it into one section of the heater, thus making for very cheap power since all the available heat in the steam is utilized. The speed of the engine is variable, and hence the quantity of air delivered may be closely regulated.

Many years of operation, coupled with the information contained in the weather log, have made it possible to construct a chart which shows the operating engineer just how fast the fan must turn and at what temperature the air must be delivered in order to meet any prevailing weather conditions. Figure 1 is a close-up view of the fan engine in Basement C. It also shows a portion of the upper half of the fan casing and the shaft going through from the engine. The fan discharge may be seen in the left background of the picture.

The second medium used for conveying heat in the building is hot water, which serves Sections A, D, G and H. A year ago last fall, after the discontinuation of our steam power-plant, the old hot-water generating plant was replaced by entirely new apparatus which was to be capable of handling any future building growth on our present site. This plant is located in Basement B, just west of the boiler room, in the small space formerly occupied by an old refuse-burning boiler.

The apparatus consists of duplicate heaters and pumps, thus insuring continuous service in case of breakdown of any unit. The heaters are arranged so that water may be pumped through them singly, in series, or in parallel; and each consists of dozens of small brass tubes contained within a steel shell. Steam condensing on these tubes imparts its heat very quickly to the water flowing through them, consequently the heaters are

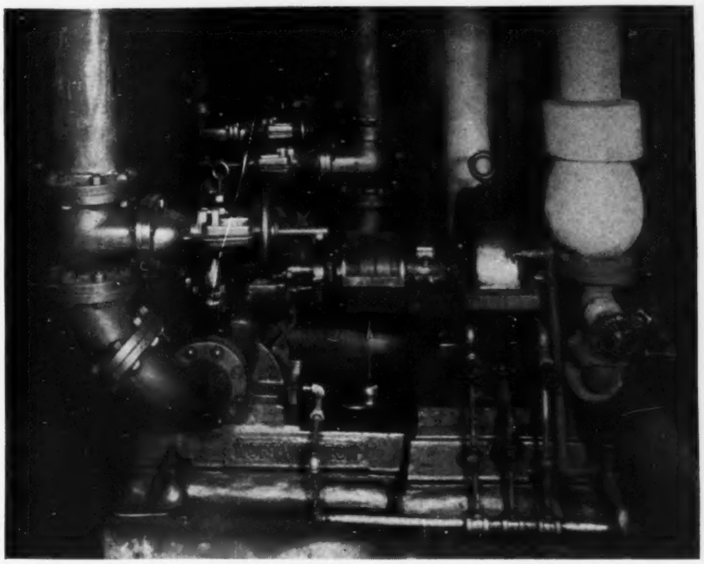


Fig. 2—The turbines which pump hot water through the radiators of Sections A, D, G and H

surprisingly small—less than two feet in diameter and not quite six feet long.

The pumps, only one of which operates at a time, force the water through the heaters and out to the sections through separate loops serving A and D, G, and H, respectively. Separate return loops are brought back to the suction side of the pump, where the water is again brought up to temperature in the heaters. The pumps are driven by direct-connected 10 h.p., 1100 r.p.m. steam turbines, which take steam at sixty pounds and discharge it into the first heater at a maximum pressure of five pounds, thus acting merely as pressure-reducing valves and at the same time providing power at much less expense in this particular instance than would be the case with electric motor drive. Figure 2 is a good view of the pumping units.

If weather conditions are so severe that the five-pound-pressure steam in the first heater cannot supply sufficient heat, the water is passed to the second unit, where any pressure up to sixty pounds may be obtained and a water temperature as high as 300 degrees F.; although of course, it is neither necessary nor practical to circulate water at this temperature.

Regulation is obtained solely by varying the temperature of the outgoing water to conform with the prevailing weather conditions, as shown on the chart. Actual operation shows that an outgoing temperature of about 125 degrees F. will make the building comfortable in the early fall and late spring days, while with zero weather the maximum is rarely more than 235 degrees. This range of over 100 degrees permits greater flexibility and economy of operation than could be obtained with steam as the heating medium.

Thermometers and control valves on the separate return loops make it possible to regulate the amount of heat sent to any portion of the building; and an instrument board placed below the heaters shows at a glance pressure and temperature conditions in any part of the hot-water generating plant. Included in these instruments is a recording thermometer, where on a circular chart, revolved once in 24 hours by clockwork, are traced in red and green ink, respectively, the outgoing and return temperatures for the day. These charts, filed daily, permit the Plant Department to determine just how much heat was supplied these sections on any day during the entire heating season.

Steam for both the hot-air and hot-water heating plants is supplied by four water-tube boilers, capable of producing some 17 tons of steam every hour. The full combined rated power of these four boilers may be used if required to heat the building under most severe conditions.

The Telephone and the Switching Locomotive

By P. H. Betts

DURING the period of readjustments following the war, few industries were confronted with more difficult problems than the railroads. One of the methods which aided materially in improving their conditions and in reducing losses is the remotely-controlled gravity-freight-yard, such as that of the Indiana Harbor Belt Railroad, at Gibson, Indiana. While this system is a vast improvement over the old way of handling freight traffic, still there is one weak link. It is in the communication chain, between the yard locomotive and the main control point.

To the Gibson yard come freight trains from all directions, made up of cars destined to go to many different places. It is the purpose of the yard to sort out the cars for each destination. The incoming train is shoved up to the top of a hill called the "hump"; a car or a group of cars is "cut" from the train and coasts down the other side of the hill into the track appropriate to its destination. The speed of a train of cars up to the hump must be closely regulated, since there must be an appropriate interval between groups or single cars to allow the safe operation of the switches. When there are a large number of cars going to one destination the speed can be greater, because the cars coupled together take less space than single cars. In case of a slip in handling any of the cars it is necessary to correct the error before proceeding with further assortment. All this requires frequent signals from the yardmaster at the "hump" to the engineman of the pushing locomotive.

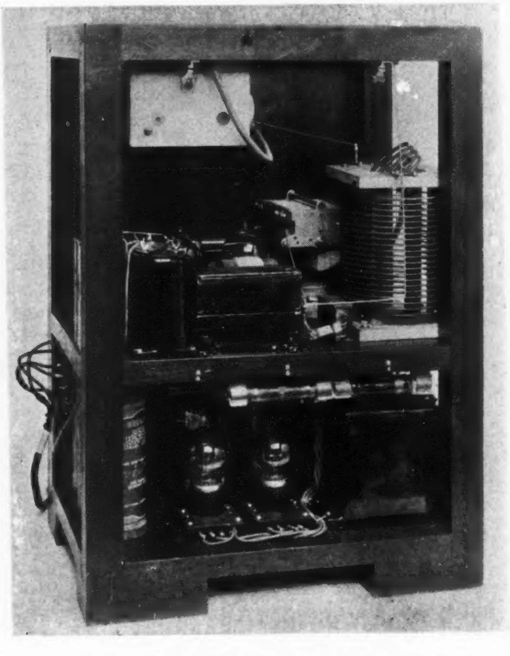
The problem was tackled in the usual railroad method—that of colored signal-lights set from a switchboard at the hump. But it is obvious that if more orders could be indicated, or if individual orders could be given to fit every specific case, the control would be more efficient. Then, too, the climate is such that there is often mist, and this almost obliterates the signals. At best the signals are only dimly visible in good daylight; and in the afternoon, the sun is back of the signal and makes its light almost invisible to the engineman. The distance of the engineman from the hump is, of course, the length of the train his locomotive is pushing, and this may often be as much as a mile. In cases of emergency, when the signal lights are totally obscured, the roundhouse whistle is used. This, of course, is cumbersome, and a better way of communicating with the engineer was sought.

With these difficulties in mind, the railroad engineers brought their problems through the Western Electric Company to the attention of our Laboratories. It was suggested by us that a radio system would give the same latitude of communication between the hump and the locomotive as was enjoyed over the existing wire-system * between the hump and the towers. As

* *This system is equipped with Western Electric amplifiers and loud speakers.*

the radio system had an appeal to the railroad officials, they offered the use of their facilities toward making an operating demonstration of such a scheme.

For these tests a small radio transmitting set and a receiver were built in the laboratories. The transmitter was designed and constructed by O. O. Ceccarini. It uses four five-watt vacuum tubes. Two of these rectify high-voltage alternating current which is obtained from a transformer, and supply the other two tubes which are respectively oscillator and modulator. This transmitter is similar to a broadcasting transmitter except that it is of low power and is designed for a short wave-length. Relays are provided so that the transmitter is put into operation by merely pushing a button on the microphone handle. The three dry-cells, which may be seen on the bottom shelf of the transmitter, supply the current for the microphone and relays. All of the other power is derived from 110-volt, 60-cycle supply, and the load required is small enough to allow this transmitter to be connected to any lamp socket.



Rear view of the five-watt transmitter

The receiver, which was designed by the writer and constructed in the laboratory, also uses four tubes supplied from batteries. The first of these acts as a radio-frequency amplifier in a tuned stage. The second tube is the detector, and the third acts as an audio-frequency amplifier. The fourth tube acts as a power amplifier to drive the loud-speaker.

The transmitter was installed in the house at the hump and a small antenna was erected between the house and the top of the pole holding the signal lights which the radio system was to supercede. One of the difficult problems was that of finding room on the locomotive for a suitable antenna for the receiver. Finally, this was given up and a small antenna was erected on the rear of the tender. This served the purpose very well, although it was only about 150 feet of rubber-covered wire wound around a form built of two-by-four timber. The receiver found a hiding place in the tool box under the antenna. The output of the receiver was connected to a loud-speaker in the locomotive cab just above the head of the engineman.

It is obvious that the engineman could not be called on to operate a radio receiver in addition to his other duties. The receiver was therefore constructed so that it could be tuned, the controls locked, and the cover closed and fastened. All that the engineman would be called on to do would be to turn it on or off, as required. When the receiver is in operating condition all that can be seen is a black box with a switch handle, and a red and a green light. The green light glows as soon as the set is turned

on; it is intended to show that the receiver is in operating condition. The red light glows in case any of the vacuum tubes burn out; the engineman, knowing that he will not get signals, should immediately stop his locomotive and have the tubes replaced.

As soon as the transmitter and receiver had been installed, tests were made to determine the range of the system. A code was arranged for answers by the locomotive whistle. No reply at all was to indicate no signal had been received. All went merrily while the engine was within half-a-mile from the hump; but then, when the engine had gone down to the end of the yard, about a mile and a half away, there was considerable disappointment in getting no answer from the locomotive. Somewhere a link had broken in our chain. An investigation showed that the link was not radio: the signals to the engineer got across, but back at the hump the locomotive whistle could not be heard at all.

After the preliminary testing the system was turned over to the yard master for practical operation. All that was necessary for him to do was to push the button on the microphone and talk, practically the same procedure as would have been used to talk to any of the towers.

It was apparent how much more useful the radio system would be than that of signal lights when the yard master told the engineman to come ahead with his train at a good speed until the first car had reached the hump. For a while it looked as though he had entirely forgotten that the cars could not be allowed to go over the hump at a speed greater than four miles per hour, as the train was approaching at a speed very close to ten miles per hour. One of the car inspectors reminded the yard master of this, and the latter made a wild grab for the microphone and shouted "Slow down to two miles an hour." The engineman had been expecting some such order, and immediately slowed the train down as directed.

Interior arrangement of the receiver

The best that could have been done with the signal lights would have been to instruct the engineman to come ahead at four miles an hour until ordered to slow down.

Very often new ideas meet with a lack of sympathy, and consequently fail to accomplish their purpose. This was not the fate of the radio system, for it met with enthusiastic recognition by all who were in touch with its operation. Inasmuch as no commercial installation has been made, and as the first demonstrations lasted but two days, no definite data can be advanced to show how much operation can be speeded up by the use of the radio telephone system. The railway engineers who were present during the tests were enthusiastic, and it may very well be that this small beginning may mean the introduction of radio telephony to the railway field.

Broadcasting in the Near East

HOW well our design of 5000-watt broadcasting equipment has upheld the reputation of Western Electric in Czecho-Slovakia is told in a news item clipped from *Narodni Ozdobozeni,* a newspaper of Prague, dated January second. The station in question was installed by the Administration of Posts and Telegraphs in Prague. Trials were made during December, 1925, and the plant was put in operation at full power during January at 360 meters. Excerpts from a translation of the news story follow:

Our new transmitting station in Strasnice of the Western Electric system has been put in action the first time on Christmas Eve. The station worked only with a power of 2½ kw. Compared with the old French station this was already great progress because the old station developed merely ½ kw. The reception of the new stations was very strong, but modulation did not show yet any advantage compared with the old outfit. We began to fear that the reputation regarding the "splendid" qualities of this equipment has been greatly exaggerated, and that its "world name" is only the result of some very skillful advertising. Thursday, however, *i.e.,* on Sylvester Day (December 31) the installation of the sending station was ready so that the engineer of the Western Electric Company has agreed at 8 p.m. to transmit with full power of 5 kw. When the hands of the clock pointed to nearly 8 o'clock, feverish excitement reigned not only in the sending station, but also in the premises of all the receiving radio sets of the Republic. Tens of thousands of souls awaited anxiously the first tones. Everybody was inspired by the wish that we "beat" London, or at least Rome.

At last 8 o'clock. Three great strokes upon a gong and then again silence, in which slowly died the tone of the metal vibration. The excitement was at its height. This vibration of the metal which was not heard previously seemed to be a doorway to the paradise and then the voice of the announcer was heard. Immediately all condensers were tuned. One has the absolute belief that the announcer is standing beside you. You hear his respiration and you imagine (is it true you only imagine?) you hear also the beating of his heart. Even he is excited, and then came what we have expected impatiently and about what we dreamed so often. Music. Yes, that is it. The sound of the tones and speech of the instruments. Outside it is raining, the wind is howling, and your room, lighted by an oil lamp, with a carpet costing Kc 15. a meter, with a used sofa and old furniture, changes suddenly into a concert hall. Everything sparkles with newness and the intense life, energy and joy. Time passes as on a summer day until the New Year's wishes of the announcer turn you back to reality.

This is Western Electric. Suddenly it became the favorite of the amateurs of the whole Republic, as can be judged from the telegrams and telephone messages from all parts of our country. Our listeners will not try to get foreign stations any more because our Western Electric beats all.

News Notes

FRANK B. JEWETT, who has been for some time a trustee of Carnegie Institute of Technology in Pittsburgh, spent March 17th at the Institute on a visit of inspection and conference. During March Dr. Jewett spoke to the Detroit Section of the A. I. E. E. on the engineering problems of the New York-Chicago cable system.

SEVERAL MEMBERS of the Laboratories and of the American Telephone and Telegraph Company are preparing articles covering different phases of electrical communication, to be used in the revised edition of the Encyclopedia Britannica. John H. Bell's subject is "Recent Developments in Landline Telegraphs"; Karl K. Darrow's, "Conduction of Electricity in Gases and Solids"; R. V. L. Hartley's "Amplifiers"; and Ralph Bown's (D. & R., A. T. & T.), "Broadcasting—Technical and Scientific Aspects."

AS ONE OF THE CONCLUDING numbers on the program of a strenuous two months' instruction in the communication art at Fort Monmouth, New Jersey, a tour of inspection was made through our Laboratories on February 26, 1926, by Major Van Deusen, Major Stanford, and about fifty staff officers of the Signal Corps, U. S. Army.

Preceding the trip through the Laboratories, a photograph was taken of the officers, which appears in this issue. The party was divided into five groups, and under the guidance of C. C. Graves, A. H. Leigh, W. A. Bollinger, A. A. Reading, and J. V. Moran, they were shown the transmitting equipment of station WEAF, tests on telephone transmitters and receivers, public address systems, the cathode ray oscillograph, the transmission of pictures by wire, insulation studies in the chemical laboratory, material testing, machine switching systems, evacuation of vacuum tubes, the telephone repeater, and the Historical Museum.

THE INSPECTION DEPARTMENT'S Field Headquarters on the Pacific Coast have been transferred from Los Angeles to San Francisco, and R. J. Nossaman is acting as Local Engineer there. A. J. Hrivnak, who has represented the Department in the Pacific Territory for the past year and a half, has transferred his headquarters to Hawthorne, where he will undertake similar work in the Mid-West territory. J. M. Schaefer, of the Mid-West headquarters, is on temporary assignment at West Street for three months. J. K. Erwin, Local Engineer at Atlanta, has spent a week in Jacksonville and Miami in connection with regular work in his territory.

During February, W. A. Boyd, R. M. Moody, and H. F. Kortheuer, of the Inspection Department, were in Hawthorne in connection with the regular Survey Conference work.

AT THE MARCH TENTH MEETING of the New York Electrical Society, Francis F. Lucas sketched the development of high-power metallography with ultra-violet light, discussing the equipment used and theory involved.

HAROLD T. FRIIS has been appointed Chairman of the Static Committee, American Section, International Union of Scientific Radio Telegraphy.

KARL K. DARROW is delivering a series of lectures on "Contemporary Atomic Theory" at the Massachusetts Institute of Technology. The lectures are open to all, but are intended primarily for graduate students and seniors in the Communications Option of the Department of Electrical Engineering.

DURING APRIL, Louis W. McKeehan is to give a series of three lectures on magnetostriction and allied phenomena, before the Franklin Institute at Philadelphia.

HARVEY FLETCHER spoke before the Brooklyn Academy of Arts and Sciences on the subject, "Physical Properties of Speech, Music and Noise."

THERE APPEARED in the November, 1925, issue of the RECORD a description of the Transcription Department's telephone dictation activities. Since that time the Transcription Department has received calls from several representatives of the Associated Companies, who have become interested in this method of handling stenographic work.

AMONG THE VISITORS to the Laboratories last month were Dr. John H. Dellinger and Dr. Hall, of the Radio Section, Bureau of Standards. They were interested in learning, from Mr. Fondiller and Mr. Shackelton, practices of the General Development Laboratory in making measurements at radio frequencies, and particularly in a shielded bridge for measuring capacities, inductances, and energy losses at frequencies as high as 1500 kilocycles. With E. L. Nelson the visitors also inspected a completely shielded room and discussed field strength measurements.

LOUIS W. MCKEEHAN has been elected a member of the Board of Editors of the *Physical Review*. K. K. Darrow is also a member of this board.

AT CARNEGIE INSTITUTE on March 9th John Mills talked to the upper class engineering students on the qualifications and aptitudes necessary for engineering work. The talk followed somewhat the lines of his published papers on "Engineering Aptitudes" and "Selecting and Placing College Graduates in Business." A more recent paper by Mr. Mills, entitled, "Starting as An Engineer," and containing some suggestions to seniors as to the selection of employment has been printed by the American Telephone and Telegraph Company, and is being distributed to engineering students at the request of their deans and professors.

CORRECTION must be made for an error in printing the name of Mr. Watson in the March RECORD. His name, of course, is Thomas Augustus, and not Thomas Alva, to which the writer was attracted by association of ideas because of another Thomas, who is also a famous pioneer in electrical communication.

THE LABORATORIES' Instrument Makers' Apprenticeship Course has recently been completed by Frank W. Brunningraber and Gilbert Haege.

Club Events—Recent and Future

MEMBERS OF THE LABORATORIES have an important engagement for Tuesday evening, April 13, in the Grand Ballroom of the Hotel Pennsylvania, where the Club is holding its spring dance. Between the dances some excellent entertainment will be presented by our Symphony Orchestra, which is directed by L. E. Melhuish. A grand march will be followed by the taking of a picture of all the guests. Ben Bernie, of radio fame, will provide the music.

IN DEFEATING THE TEAM from the Tide Water Oil Company on Saturday, March 6th, our team in the Commercial Chess League of New York City finished its third consecutive season without the loss of a match. *This gives the Bell Laboratories Club permanent possession of the Potter trophy.* Our success in this League has been due to the combined efforts of H. M. Stoller, chairman of the committee in charge of chess activities, F. A. Voos, team captain, and of the players who for the past three years have given their time to this undertaking.

ON SATURDAY, April 3, in the West Street Building, the chess team will meet the Hawthorne Club in their annual chess match. To the winner of this match will go the trophy which has been donated jointly by the Bell Laboratories Club and the Hawthorne Club. At the present time this trophy is in possession of the Hawthorne Club, as it was the winner of the 1925 tournament.

SOMETHING RATHER SPECIAL in the way of a chess match was staged on Saturday, February 27, when a team of young hopefuls captained by D. G. Grimley put to rout a selected team of hoary veterans led by F. A. Voos. Each side was represented by a first and second team of five chess wizards.

FIRST TEAMS

Young Hopefuls

1.	D. G. Grimley	1
2.	R. L. Dempsey	1
3.	H. D. Cahill	0
4.	E. G. Andrews	1
5.	J. Redington	1

Octogenarians

1.	F. A. Voos	0
2.	H. T. Reeve	0
3.	H. A. Whitehorn	1
4.	G. H. Heydt	0
5.	C. R. McConnel	0

SECOND TEAMS

Young Hopefuls

6.	F. A. Zupa	0
7.	H. O. Wright	0
8.	A. R. Rienstra	0
9.	W. Kuhn	1
10.	M. E. Krom	1

Octogenarians

6.	H. M. Stoller	1
7.	T. J. Galore	1
8.	J. A. Hall	1
9.	A. M. Granich	0
10.	G. F. Morrison	0

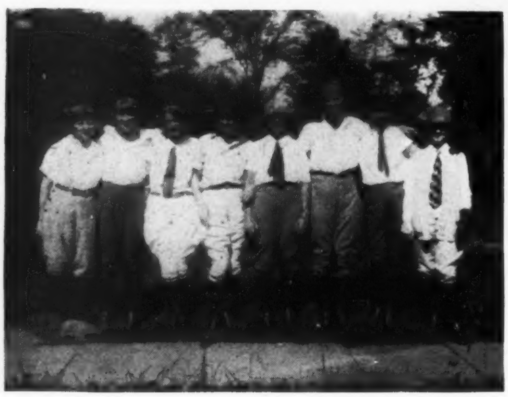
A WOMEN'S BRIDGE TOURNAMENT of six games will close the 1925-1926 season. The first three of these games were played on March 17, 24 and 31, and the remaining three are scheduled for April 7, 14 and 21. Each week the regular prizes are

awarded, and the two players making the highest total number of points for all six games will be adjudged winners of the tournament and the two prizes which the Club will donate. The games are planned and the prizes selected by Mary Murtagh.

As THE ENTHUSIASM with which our first golf tournament was received has indicated the advisability of planning others, the Golf Committee is now working on arrangements for the first of two tournaments scheduled for the 1926 season. Each of these matches will have two rounds of eighteen holes each of medal play with approximately thirty golfers qualifying for the finals. They will be played on the links of the Salisbury Country Club, Salisbury Plains, Garden City. The first match will be held during the early part of June.

Golf cages will be available for practice on the roof of Section G about April 15.

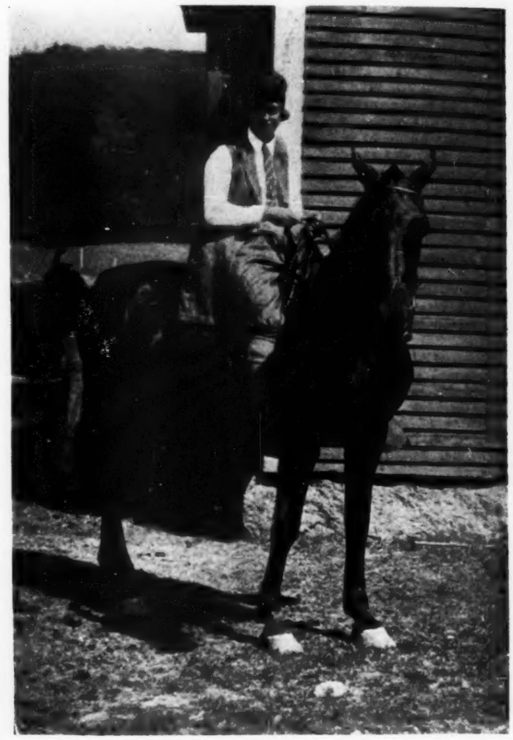
Further information regarding these tournaments may be had from



A group of hikers

D. D. Haggerty, or from any member of the Golf Committee, which includes: E. J. Johnson, E. C. Mueller, W. Kidde, G. Heydt, K. B. Doherty and D. D. Haggerty.

ON TUESDAY EVENING, May 13, the Club team will play its first game in the newly-organized Bell System Baseball League, against the team representing the Northern Division of the New York Telephone Company. It is hoped that every Club member will make plans to attend this game, which will be held at the Erasmus Hall High School Field at



One of our equestriennes "at rest"

Gravesend and Twenty-second Avenues, Brooklyn. The support of a crowd of rooters is a big factor in the success of any team, and nowhere is "moral support" more effective than in the great American game — baseball. The New York Telephone Company team is reputed to have a great following. Our Club members are urged to remember the date, May 13, and to come and drown out their famous "wahoos" with some original

and snappy ones of our own. The field has a seating capacity of 3000—plenty of room for everybody.

Manager Bartheld will hold tryouts for the team in April. He is now ready to hear from all ball players who would like to become members of the team.

E. J. Johnson, Chairman of the Athletic Committee

The schedule for the season is as follows: Thursday, May 13, New York Telephone, Northern Manhattan; Monday, May 24, New York Telephone, Southern Manhattan; Thursday, May 27, American Telephone and Telegraph; Monday, June 14, New York Telephone, Long Island; Monday, June 21, Western Electric, Headquarters; Tuesday, July 6, Western Electric, Hudson Street; Thursday, July 15, Western Electric, Installation. All games will be played at Erasmus Hall Athletic Field, Gravesend Avenue, Brooklyn, starting at six o'clock.

The Interdepartment Baseball League will open its third season on Saturday, May fifteenth, at Erasmus Field.

IT WILL BE POSSIBLE this spring and summer for our horseback riders to enjoy the delightful bridle paths of Ocean Parkway and Prospect Park in Brooklyn. Arrangements have been made with the Unity Riding Academy for the use of their horses at a charge of $1.50 an hour. The horses are guaranteed to be gentle, well trained, and well acquainted with the roads. For an extra charge the services of a riding master may be obtained.

In order to take advantage of the reduced rates it is necessary for Club members to purchase their tickets through Miss Gilmartin or the Club Secretary.

COMMERCIAL'S victory over the Equipment basketball team at Labor Temple on Friday evening, March twelfth, made certain their winning of the league championship for the 1925-1926 season.

Miss Helen Cruger, Women's Representative

Basketball history was made on this evening, and the spectators who were fortunate enough to witness this contest will never forget the spectacle of these two powerful teams battling for a title. The Equipment team went into the game with one defeat charged against them; knowing that one more loss would put them out of the championship race, they fought one of the hardest games seen in years among the West Street teams.

L. P. Bartheld, Baseball Manager

However, Commercial was just as determined to win, and the result was a game every bit as good as one might see on

the Madison Square Garden court.

Title hopes rose high for Equipment at the end of the first half, when they were leading by two points; but in the second half the superior playing of the best departmental team ever organized at West Street won by a score of 23 to 18.

Three members of the championship team are among the first five individual high scorers:

Standing of the Teams

	Won	*Lost*	*Percent*
Commercial	11	0	1000
Equipment	9	2	818
Jr. Assistants	5	6	454
Toll and Circuit	5	6	454
Research	5	6	454
Tube Shop	4	7	363
App. Development	4	7	363
Pat. Inspection	1	10	099

Individual Scores

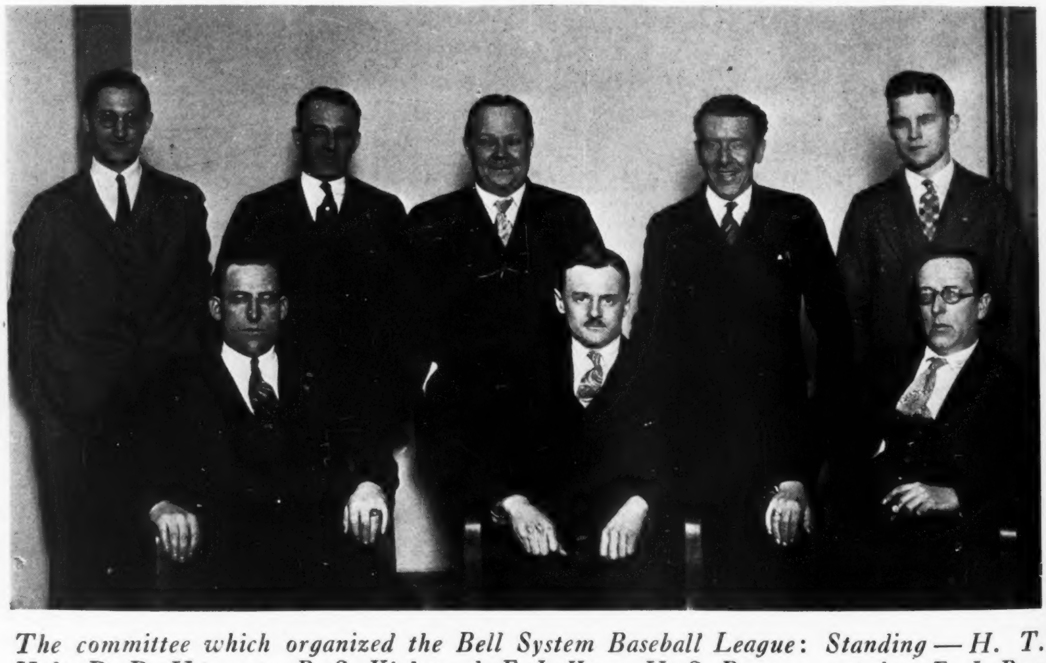
	Games	*Goals*	*Fouls*	*Points*
Maurer, C., Comm.	11	59	20	138
Trottere, W. P., Equip.	10	47	13	107
Steinmetz, W., Comm.	10	35	15	85
Hansen, A. T., Comm.	11	32	20	84
Elliott, H., Research	10	25	23	73

MARCH TWELFTH seems to stand out quite prominently as far as basketball is concerned. It was a most important night for our men's league, and it was just a little bit more important for our women.

On the evening of this day, at Stuyvesant High School, our girls, playing their first game in outside competition, met and defeated, by a score of 13 to 2, a team representing the general offices of the Western Union Telegraph Company.

Those who played on the team against Western Union were: Helen Vickers, Alice Pease, Marie Boman, Jeanne Hassett, and Ethelyn Boyer. In preparing for the game the team went through rigid training under the direction of Miss Boynton, physical director of the Houston House.

Our success in this first game has prompted us to schedule one or more games this season, and it is hoped that we can always have a team in the future which shall represent us in outside competition.



The committee which organized the Bell System Baseball League: Standing — H. T. Holt, D. D. Haggerty, R. S. Kirkwood, F. J. Kane, H. S. Brown; seated — E. J. Porteous, J. B. Stearns, T. E. Walker